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MUNICIPAL TELEPHONY: AN AWAKENING.

IT appears that the result of the negotiations between the five telephone municipalities and the Post Office is that the two parties are unable to come to terms; the municipalities are unwilling to accept the best offer the Postmaster-General is able to make. Just what the offer was, and on what grounds it was refused, are facts that have not been published. It is known that there was recently a conference of the Telephone Committees of Glasgow, Hull, Brighton, Portsmouth and Swansea, held in London, and a deputation to the Postmaster-General, the proceedings in both cases being strictly private. But some of the local papers in which the views of Town Councillors find ready and forcible expression, have stated that an offer has been made and refused, accompanying the statement with some rather strong language addressed to the Post Office and the Local Government Board, which are accused of treating municipal interests and susceptibilities with little tenderness.

It will be remembered that these negotiations, which seem to have resulted in a severe municipal disappointment, started with the telephone debate in the House of Commons last August, when the then Postmaster-General said he was willing to negotiate with any of the telephone municipalities which wished to sell out to the Post Office. Since then there have been various conferences of the municipal telephone authorities and various meetings between those authorities and the Post Office officials, while from time to time there have appeared encouraging paragraphs in local newspapers, saying that the municipalities were going to get all their money back, and something on top for goodwill! Such suggestions showed more than a touch of what a writer the other day happily termed the "invincible optimism of ignorance."

But the Postmaster-General has necessarily conducted his end of the negotiations in a practical manner. He was asked to buy mechanical and electrical plant, and he proceeded to make an expert examination and valuation of that plant. Post Office engineers were deputed to make a detailed inspection of the municipal telephone system in each place, and on the reports and valuations of those engineers the Postmaster-General has doubtless based his offer. An official charged with the responsibility of spending public funds could naturally proceed in no other way. Anyone familiar with the history of the municipal telephone undertakings will readily understand that an offer to purchase based on a serious expert inspection and valuation of the plant in use could not be acceptable to the municipalities concerned. It is tolerably well known that the municipal telephone systems have not been built in strict conformity with Post Office engineering standards, and that they contain much apparatus of an obsolete type. As in no case has any serious allowance for depreciation been

made, there must obviously be a considerable loss to be faced by someone whenever the municipal telephone experiments are wound up. The municipal authorities, who have so lightly spent something over half a million on an ill-planned and futile telephone competition, expected the loss incurred to fall on the Post Office; but the Postmaster-General and his advisers are apparently not prepared to throw business methods to the winds, and to help out the ratepayers at the expense of the taxpayers.

The municipal telephone business has neither been good telephony nor good business. The class of telephone work done has been deficient in various respects, and the cheap rates adopted, having been based on preliminary estimates that were greatly exceeded when the work came to be done, have been quite uncommercial. Under such unfavourable conditions, and with an active competition to face, the municipal telephone crusade, which started with such a blare of trumpets, has soon degenerated into a pitiful struggle to capture some small share of the rapidly growing telephone business of the various towns and to keep up appearances in the eyes of the public. There has been much tall talk in the Council Chambers and in the lay Press, but all semblance of doing a serious telephone business has long ago disappeared, and during the past year the various municipal systems have relapsed almost into a state of stagnation. In Glasgow, for example, according to the published statistics, the municipal system gained last year only 597 stations, whereas the National Co.'s system gained 5,725 stations. In most of the towns where there is municipal competition in telephony, the National Co.'s system is now double, or more than double, the size of the municipal system, and in every case is increasing at a much greater rate.

Therefore, in every way the municipal telephone competition has been a failure. The few municipalities which have embarked on it have wasted much money by starting a difficult and very technical business without giving the subject the consideration it deserved. Misled at first by optimistic estimates, they afterwards felt bound to maintain the unduly low rates which were the main feature of the municipal telephone propaganda, and have consequently failed to provide for depreciation in sufficient measure to safeguard the capital invested. We have been told repeatedly that no depreciation is necessary in telephone work, especially in municipal telephone work, and that a thirty-year sinking-fund is "excess of caution." It is now evident that those best qualified to judge think quite differently on this important subject of depreciation. Perhaps now that five municipalities have been unable to convince the official telephone authorities of the country that there is no depreciation in telephone plant, those municipalities, and many others, will look a little more carefully at the depreciation item in their electric lighting and tramway accounts.

Contracts by Tender.

Engineers and contractors who make tenders for the supply of machinery, &c., to local bodies are frequently met with the vexatious condition that, unless certain parts of that machinery are of a certain type or are made by a particular firm, the tender stands no chance of being accepted. We are informed that a certain municipal council having resolved to extend its electricity plant, recently sent out to a number of electrical manufacturers a specification in which a special type of engine (one firm's exclusive speciality) was asked for, the type of generator being left open. The matter was not advertised. A firm of engine builders not making the type specified by the engineer obtained permission to tender, but, contrary to specification, they quoted for *their own* type of engine. Their price was lowest, but they were ruled out as having failed to comply with specification.

The following points arise:—(1) Should the matter have been settled without the contract being publicly advertised? (2) Was the engineer acting within his rights in specifying a particular type of engine—a fact which conceivably might allow of the price being increased because of the "monopoly" given to that favoured type?

Our readers are well aware that it is a frequent practice for dynamo builders to submit alternative tenders for their machines driven by different types of engines. In this way the engineer can obtain his end without leaving an opening for unfair competition.

Bearing in mind that the local authority in question was a *municipal* body, the legality of this particular method of obtaining tenders is open to question. In the first place, it is provided by Sec. 174 (4) of the Public Health Act, 1875, that before any contract of the value or amount of £100 or upwards is entered into by an urban authority, 10 days' public notice at the least shall be given, expressing the nature and purpose thereof, and inviting tenders for the execution of the same, and such authority shall require and take sufficient security for the due performance of the same. If this statute applies, and there is nothing to show that it does not apply to every municipal council, it seems to be clear that public tender is a *sine quâ non*. The object of the legislation is manifestly clear; it is to give to the public an assurance that there shall be no favouritism, and that the ratepayers' money shall be expended as economically as possible. At the same time, it is well to note that Mr. Macmorran, in his well-known edition of "Lumley's Public Health," points out that this provision is directory only, not obligatory. We cannot, however, find any further authority for this exposition of the law; and we prefer to accept the view that public advertisement is necessary. Assuming that this is the correct view, the further question remains—Is a municipal body at liberty to state that no tender will be considered unless it include a particular type of engine? Although there does not appear to be any direct authority on the point, it constitutes, to our mind, a grave abuse of the powers which are conferred upon local bodies by Parliament, and opens the door to grave abuses. In view of its importance—and in the absence of express legal authority upon the point—it is a matter with regard to which those who are interested in the supply of electrical machinery might well take concerted action. Should it turn out that there is no remedy available, they will know their position; if there is a remedy it can easily be put in force.

India-Rubber.

"The *Times* Financial and Commercial Supplement" of last Monday contained an interesting article on the "Growth of the Rubber Trade." The enormous expansion in the commercial demand for india-rubber has caused the price to become doubled during the last five years. The best Para fetched as much as 5s. 9d. a pound last year; since the opening of 1906 prices have ranged from 5s. 3½d. to 5s. 5d., and even these have been exceeded in the case of some rubber grown in Ceylon. The production last year, from all sources, is stated to have been 65,000 tons, of which Brazil contributed 34,000 tons, or more than half. Under the stimulus given by high prices these figures are likely to go on increasing. The writer mentions the unexplored regions of the Acre which are believed to contain 80,000 square miles of rubber forests, and thinks that when

railway communication is, in the near future, opened with that district a very large increase in the quantity of rubber will result. Brazil is to pay two million pounds sterling towards the cost of this railway, and half that amount has already been handed over to the Bolivian Government. Money will do a good deal when in capable and honest hands, but we have very little expectation of ever seeing the price of rubber influenced by any railway to these inaccessible and terribly unhealthy regions. Brazil, especially the northern provinces of Para and Amazonas, almost owes its existence to the rubber fields which bountiful Nature has bestowed; and, in spite of the wasteful methods of collection employed, the high wages demanded by the collector, and a general moral corruption which is probably unequalled in any other part of the world, still remains the principal source of supply. This is in no small measure due to the wonderful network of waterways which in this country take the place of roads, and afford a ready and cheap means of transport through what would be otherwise inaccessible jungle.

That Ceylon and the East Indies will in the near future be among the chief producers of india-rubber, there can be little doubt, and we do not at all agree with the writer of the *Times* article in thinking that new companies which are starting to plant trees are likely to be some years behind the fair. The demand is likely to increase even more rapidly than the supply, and it will be met by workers who believe in the principle that "God helps those who help themselves," and not by any great increase in the exports of the natural rubber of Brazil, which must be limited by the supply of labour obtainable for its collection, a work which can only be carried out by the native-born, and even then at a terrible sacrifice of life.

An "Electropathic Doctor."

The attitude of the Law towards quacks and quackery is, to say the least, a tolerant one. Still the line has been drawn. Any person calling himself Doctor in connection with the cure of disease, whose name does not appear on the Medical Register, is liable to conviction under the Medical Acts. Such was the practice and such the fate of Frank Lee, of the Bristol Electropathic Institute, who, on February 13th, was fined £10 and £5 costs at the Bristol Police Court. But the true inwardness of this affair did not begin and end with Frank Lee. He stated in evidence that the business did not belong to him, but to a clergyman and a Justice of the Peace, whose paid representative he was. It is a pity that the names of these two worthies have not been made public. Perhaps *Truth* will kindly look into the matter.

The designation of the Institute, "Electropathic," will sound familiar in the ears of those who remember "the nineties" and a famous "Electropathic" belt case, in which this journal took a prominent and successful part. Although these two cases have nothing in common but the name, the survival of the latter shows a very undesirable vitality. It doubtless points to a continued demand on the part of the public for electrical quackery in one form or another. Whilst such a demand exists there will continue to be persons (let us hope not *always* clergymen and magistrates) ready to pander to and profit by it. For this unwholesome state of things perhaps an antidote may ultimately be found in the increasing number of "orthodox" practitioners who are adding to their medical qualifications an adequate knowledge of electro-physics. The latter is a hopeful sign, and we warmly welcome it.

Lost Opportunities.

A meeting was held in the Mansion House on Monday afternoon, February 26th, for the purpose of taking such steps as were necessary to commemorate the fiftieth year of the foundation of the coal-tar colour industry, and to do honour to Dr. W. H. Perkin, the discoverer of the aniline colours, which he introduced to this country. Dr. Perkin still lives to laugh, it may be, at the fatuous policy of his country's industrial leaders, and to see the huge industry that his discoveries have founded in Germany.

Lord Rayleigh, Sir Henry Roscoe, and other speakers who supported the chairman, the Lord Mayor, made touching reference to what this country has missed and Germany has gained, and there seemed to be an idea that better technical education was going to improve matters. This we very much doubt. There was sufficient technical and scientific knowledge in the mere boy, who is now the aged Dr. Perkin, to discover the coal-tar colours, but there was not sufficient appreciation of the discovery on the part of capitalists and manufacturers to make use of it. There were German chemists in this country who tried to push the invention here, and they all went back to Germany and founded the aniline industry there after vainly endeavouring to establish it in the country of the inventor. Things do not seem to be any different to-day. For example, there is in Germany to-day some 360,000 H.P. developed by blast-furnace gas power, the discoverer and pioneer of which is an Englishman—B. H. Thwaite. In Great Britain there is only 6,000 H.P. after twelve years. Is not this simply a repetition of the aniline colour fiasco? When Thwaite brought out the blast furnace power idea Great Britain was probably the leading pig-iron producer of the world. We have not the statistics before us, but we do not think the United States had then gone ahead to first place. To-day Great Britain is third. What have the British ironmasters been doing all this time? Why have they not profited from the aniline colours example? It seems to us that, though Dr. Perkin fully deserves all the recognition that it is proposed to accord to him, this recognition comes just 50 years too late. The establishment of the industry in Great Britain would have been a sufficient monument, and we could then have quoted "Qui monumentum quærit, circumspice." To-day this monument is to be found in Germany, and Great Britain is to have a picture of Dr. Perkin, a bust and a Perkin Research Fund—all very proper in their way, but sadly belated.

Nickel Steel Wire for Submarine Cables.

As long ago as April 26th, 1895, we drew attention to the advantages which might possibly be gained by the employment of nickel steel wire for submarine cables, and we believe that trials were made by a French manufacturing firm, but with what results we never heard. An article on "Nickel Steel, and its Application to Boiler Construction," which recently appeared in the *Iron Age*, New York, brought the matter back to memory. Considering that the corrosion of the wires of a submarine cable, by which they lose their strength, while increasing in weight, is generally the limiting factor in their lives, one can hardly understand why experiments as to non-corrodibility have not been made. It would certainly be to the advantage of companies owning long lengths of cable in shallow tropical waters that the matter should receive attention. Mr. Yarrow came to the conclusion that "a boiler would require to be re-tubed two and a third times as often with mild steel tubes as it would with nickel steel tubes," while the gain in strength or saving in weight with the latter would be as much as 26 or 29 per cent.

Telegraph Poles.

Small local authorities—and even some of the larger ones—of late have manifested a strong disposition to oppose the erection of telegraph poles, on the grounds that overhead wires are unsightly and unnecessary, and that the time has arrived when the Postal authorities should put all the wires underground. Needless to say, the powers of the Postmaster-General enable him to override such opposition; but the spirit underlying this movement is worthy of notice. The municipal authorities are obviously ignorant of the heavy cost of placing the wires underground, but in this, as in other cases, their ignorance does not in the least deter them from airing their opinions. It would not matter if they had no power to interfere, but unfortunately they have to be reckoned with in each case, and are able to delay progress—not only in telegraphic work, but also in other directions. It is a pity that there is no means of educating them to appreciate the facts. The daily Press, the natural medium for conveying such information, is only too often itself immersed in the mists of ignorance and prejudice.

THE BIRKELAND-EYDE PROCESS FOR MAKING NITRIC ACID.

A lecture was delivered last winter by Prof. Dr. Otto N. Witt before the Technical High School at Berlin on the utilisation of atmospheric nitrogen. Dr. Witt began by sketching the history of the attempts that have been made to effect the synthesis of nitrogen compounds from the atmosphere, and then proceeded to discuss the Frank process for making calcium cyanamide and its derivatives from, or during the manufacture of, calcium carbide. The lecturer regarded this process in a favourable light, but pointed out that a method of preparing ammoniacal nitrogen must be less generally useful than one which yields nitric nitrogen. This is the case because nitric acid is so important a reagent in modern applied chemistry, and also because a nitrate is at once available as a plant fertiliser, whereas ammonium compounds require the intervention of nitrifying organisms before they can be assimilated by vegetable growing matter.

Dr. Witt accordingly turned his attention to the experiments that have been carried out upon the direct formation of nitric acid from the air. He stated that the Bradley and Lovejoy process, which was being worked by the Atmospheric Products Co. in the United States, as well as the Kowalski-Moscicki system, which has been tested on a large scale in Europe, had both been abandoned, the sole survivor of the attempts hitherto made in this direction being the Birkeland-Eyde process. Dr. Witt described the original form of the apparatus used, and explained how it had been modified in various ways; but the essential features of his address upon this particular branch of the subject have already been given in our columns. One of the great difficulties or objections urged against the Birkeland-Eyde process is the trouble and expense involved in working up into acid of merchantable strength the very weak acids and highly diluted acid vapours issuing from the apparatus. Not much information has been made public upon this part of the operation, but Prof. Witt states that the difficulties have been overcome, and describes how this has been achieved, he having visited and inspected the factory on several occasions.

The best-known form of the Birkeland-Eyde apparatus, vertical in disposition, and taking a current of 5,000 voltage, has been at work regularly at Notodden, in Norway, since last May, and has proved satisfactory. On an average, the output is 500 or 600 kilogrammes of 100 per cent. nitric acid per KW.-year. Frequently the yield is higher than this, but it is not desirable to base calculations upon more favourable results. Careful investigations have shown that electrical energy can be developed by the syndicate controlling the Birkeland-Eyde process in Norway at an average price of 12 marks per 1 H.P.-year. [This figure, it will be seen, is very much lower than that quoted by certain other writers. It is equal to 16 marks per KW.-year; or, on an 8,000-hour basis, to 0·2 pf., *i.e.*, 0·25 centime per KW.-hour. If the average make is 550 kg. per KW.-year, 1 metric ton requires energy to the amount of 1·82 KW.-year, and the cost of this should be roughly 29s. Thus, instead of the cost of the energy absorbed in making electrical nitric acid being alone more than the selling price of ammonium sulphate, it is only somewhere about one-eighth thereof.] At the price for current mentioned, the nitric acid made by the Birkeland-Eyde process is able to compete with Chili saltpetre; and it should not be forgotten that the known deposits of the latter will not last more than another 20 years—Vergara prophesying that they will be exhausted in 1923.

The air which comes away from the apparatus is a hot mixture of oxygen and nitrogen containing barely 2 per cent. of nitric oxide. The nitric oxide combines of itself with the excess of oxygen to form nitrogen tetroxide, and the latter yields nitric acid when brought into contact with water, more nitric oxide being set free; but since these reactions take time, it is not possible to recover in one operation as nitric acid the whole of the combined nitrogen of the electrified air. At Notodden the gases are first deprived of their sensible heat by being led through boilers where steam is raised, the steam afterwards serving to evaporate the nitrate liquors which are finally obtained. In a new plant now being erected, the hot gases are to be led directly through the evaporating pans, a change in procedure which will effect a considerable economy. It is even proposed to use the steam generated by the heat of the gases to actuate turbines, and to employ the latter to drive dynamos, so that part of the spent energy may be recovered and caused to electrify a fresh quantity of air.

The cooled gases are then led into large towers constructed of acid-resisting masonry, where the speed of travel will be so far reduced that time is given the nitric oxide to be oxidised into tetroxide. From these towers the gases pass into the condensing apparatus, which are constructed of granite plates and filled with quartz. Here they encounter a constant of stream of water, which is thoroughly distributed over all parts of the columns. The liquid escaping from the bottom is raised again to the top by means of montejus, and continues to circulate till it consists of nitric acid of 50 per cent. strength when it is withdrawn from the plant. This acid is neutralised with limestone, so as to form a solution of calcium nitrate, and mixed with other liquors coming from other towers charged with chalk. The whole is then evaporated, and the calcium nitrate is finally run in the molten state into iron drums, where it solidifies. The existing plant is capable of producing 1,500 kg. of 100 per cent. nitric acid, or its equivalent in calcium nitrate, per day; and it has been found that the substance can be sold at a price which allows it to compete satisfactorily with Chili saltpetre on the basis of the amount of combined nitrogen it contains.

At present the calcium nitrate made can be disposed of easily, but as it is intended to increase the capacity of the apparatus in use at Notodden and elsewhere, the question arises whether the whole of the future output will be saleable in the same form; this will probably not be the case. Nevertheless, calcium nitrate has already proved a valuable fertiliser, having an advantage over Chili saltpetre (sodium nitrate) owing to the nature of its basic constituent. When large quantities of sodium nitrate are employed for agricultural purposes, it is frequently observed that the sodium acts prejudicially upon the vegetation; whereas, especially on soils poor in lime, the calcium nitrate is valuable both for its nitrogen and for the lime it introduces into the ground. Again, the synthetical calcium nitrate is necessarily free from all chlorine compounds, particularly perchlorates, which is an important consideration in agriculture and in other branches of chemical industry. Moreover, it has been discovered that a basic calcium nitrate exists, which can be prepared in a state of powder, and which has but little of the hygroscopicity that is a defect in the normal salt.

The nitrogen of the atmosphere can be obtained by electrical treatment in the form of nitrites as easily as in that of nitrates. Nitrites are very important reagents in the colour trade, and it, therefore, seems possible that they may be synthesised directly, instead of being prepared by reduction of Chili saltpetre as is done at the present time.

The quantity of saltpetre exported from South America is so great that all the water-powers of Europe, according to Dr. Witt, would not suffice to manufacture an equal amount of synthetical nitrate; and the demands of agriculturists for nitrates are so extensive, that very much larger quantities could be put on the markets without leading to any ruinous competition in price. It would seem, therefore, that the immediate future for the synthetical product lies in those branches of applied chemistry and agriculture where absence of chlorine and sodium compounds is desirable; and that afterwards, as the supplies of natural nitrate begin to fail, the manufacture of the electrical product may be slowly increased to take its place. This will give a young industry, which has only been in existence for three years, time to effect various improvements and so to strengthen itself that it may perhaps be able eventually to supply us with all the nitric acid and nitrates we require.

Metallurgical Microscope.—In view of the special requirements of the microscopical examination of metallic surfaces which has come into such remarkable prominence of recent years, a microscope of an entirely new pattern has been devised by Mr. W. Rosenhain, and is being made by Messrs. R. & J. Beck, Ltd., of 68, Cornhill, E.C. This firm is also making an optical bench for illumination with either ordinary or monochromatic light.

STEAM TURBINES.

By W. H. BOOTH.

If rumour be true, much trouble is being found with the blades of steam turbines, both small and large. Great secrecy is maintained, but so far as can be gathered, the chief trouble is due to the stripping-out of blades under the influence of something which is deleterious to them. It cannot be water in all cases, because we hear of stripped blades where the steam is superheated.

When the trouble arises as a result of water, it appears probable that the turbine blades are bent or even broken by the shock to which an encounter with a heavy mass of water would give rise. Water is so heavy and so inert that the rapidly moving blades of the turbine cannot move it at their own speed, and thus become bent. But in bending they are forced into contact with the guide blades, and once there is forcible contact of the running with the standing blades, there is imminent risk that some blades must be broken, and when a single blade is broken loose it is impossible to say how many more will follow. Nor does it require much displacement of a blade to produce contacts that may prove disastrous.

The lesson to be learned from this may be that the blades should be attached to a circumferential ring, of such width that the edge of the ring should make contact with the ring of the next circle of guides, in place of allowing the individual blades to run together like the teeth of a great pile. But this safeguard, already tried, may not fully protect long blades.

When damage is caused by superheat, there may be two reasons. First, the high temperature may cause unequal expansion of the casing and of the rotor, though it is difficult to see why these two parts should attain a different degree of temperature. It is, however, more likely that the temperature of the steam attains such a degree as to injure the blades. Gun-metal and other of the copper alloys become very weak or rotten at a high temperature, and probably suffer a great diminution of strength at a temperature even much below that of actual rottenness. This temperature trouble is one of the difficulties of the turbine. A superheat of 100° to 150° F. is desirable; but if an ordinary superheater is arranged to give this temperature as a maximum, it will be found that for the greater portion of the time the temperature will fall very far short of this maximum, or, if a superheater be arranged to give usually a temperature of 100° or 150°, it will occasionally go far beyond this point, and endanger the material with which the steam makes contact.

No superheater without a special system of water control can, in fact, be guaranteed, in the writer's opinion, to give a sufficient degree of superheat without the risk of an occasional excess of temperature, leading up to the risk of disaster. In this respect the turbine is at a disadvantage as compared with the reciprocating engine. The parts of the turbine soon attain the mean temperature of the steam that flows by them. The reciprocating engine is under the same laws, but different conditions prevail. The contact of superheated steam is not maintained long enough to permit of any part attaining the temperature of the steam, for hardly has boiler steam been admitted to the cylinder before it begins to expand and to cool, and then the exhaust opens, and the cylinder is exposed to a temperature of, perhaps, 120° F. No part becomes so hot as the boiler steam to any great depth, before the cooling effect of the exhaust steam is experienced.

Obviously, what the turbine demands is superheat to enable it to escape from water bombardment, and a well-controlled superheater to enable the temperature of the steam to be kept reasonably steady within narrow limits of deviation. Only by this means can a superheat temperature of reasonable sufficiency be secured without the risk of occasional dangerously high temperatures.

Until all turbine manufacturers have brought their minds to grasp the principles of steam engineering, as applicable to the turbine as a heat engine and a piece of metallic and mechanical construction, they need not expect to meet with the success that has been anticipated, and which the steam turbine ought to secure under correct management.

It is not correct to consider that the steam turbine has a "cylinder" absolutely adiabatic. True, it is not exposed to a wide fluctuation of steam temperature when working with a steady flow of steam. But turbines are frequently regulated by the system of gusts, and after each gust of steam the temperature of the condenser may be said to extend back right to the first row of blades, and in this event the whole interior of the turbine is exposed to the maximum range of temperature that can occur with a reciprocating engine. But the exposed internal surfaces of the casing, the rotor and the blades of these two pieces—often thousands in number—possess an area very much in excess of that of a piston engine of equal power. And not only is the surface greater; it is closely and intimately mingled with the steam, which is divided up into innumerable thin slices and continually turned over and over between the many blades, whereas, in the reciprocating engine most of the steam is far away from the metal, never touches it, and where there is air mixed with it, is very soon insulated from the metal by a film of air that separates out from the steam that does condense upon the surfaces. The turbine is therefore in a worse position than the reciprocating engine as regards cylinder condensation, and this is just the point on which it should be so much superior. The advantage is thrown away by the gust system of steam admission and the relative amount of condensation might be calculated from a drawing of any given turbine, except so far as regards the extreme exposure given by the slicing up of the steam into so many thin sections. The relation of the number of gusts to the number of strokes of the reciprocating engine of equal power, would of course require to be included in the calculation to give the number of the fluctuations of temperature per unit of time.

Apart from this system of regulation, the steam turbine only loses heat by radiation from the casing and by conduction along the casing and rotor, and these losses scarcely appear likely to be sufficient to account for the amount of superheat that is known to be required in the turbine.

The lesson to be drawn if the ideas above outlined are correct, and it is not easy to see how they can be incorrect, is, first, that the steam turbine should be worked at or near its maximum loading, in order that the flow of steam may be steady and continuous; and, secondly, that it should preferably be regulated by some throttling device and not by intermittent admission of the steam.

So far turbines are not understood to have shown a serious, if any economy over reciprocating engines, and it has been supposed that the economy due to the avoidance of cylinder condensation has been counteracted by the leakage of steam past the blades or by other more or less obscure internal action between the steam and the blades. But the lack of expected economy may very well be attributed to the perhaps increased initial condensation from which the gust regulated turbine must suffer. Indeed, apart from the loss by condensation there must be a serious loss from the braking action due to the water thus formed and beaten about by a thousand blades at high velocity, as in a "devil" disintegrator. From this mechanical water loss, the reciprocating engine is free, and the turbine can be freed by the aid of superheated steam.

Another disadvantage of the gust system of regulation is the variation of temperature of the blades. This probably tends to produce disintegration, and may be partially to blame for some of the rumoured stripping.

There could be no such rapid change of temperature with a throttling system. The case against gust regulation is sufficiently strong for this latter point not to be dwelt upon longer. It is very probable that the gust regulator will be recognised as an uneconomical device that should not be employed even with superheat, and is undesirable without it.

Southport Tramways.—During a fog at Southport last week a collision, which might have had much more serious results, occurred on the Tramway Co.'s system. An electric car from Churchtown having arrived at a loop without any indication of the approach of the car which it should have met there, was driven forward, and a collision resulted. Both cars were travelling at a speed of about four or five miles an hour, and the impact was severe. All who were on the cars were more or less injured.

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ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL PROGRESS IN 1905.

By F. S. SPIERS, B.Sc., A.M.I.E.E.

(*Concluded from page* 322.)

Fixation of Atmospheric Nitrogen.—Whether it is on account of the instinctive fear that there may be no possibility of growing any more wheat in about 50 years, or whether on account of the inherent scientific interest of the subject, the question of making nitrates from the air by means of electric discharges has certainly been the object of engrossing public attention during the past few months. The immediate cause of this has been the initial successes of the Birkeland and Eyde process, which is now being worked on a commercial scale at Notodden, near Christiania, for the manufacture of basic nitrate of lime, already known as Norwegian saltpetre, and considered as an equally good fertiliser as the rival Chili product. The essential condition for efficient results in these electric discharge processes is the rapid removal of the nitric oxide from the heat zone of the discharge, or arc, so as to prevent decomposition. In the Birkeland and Eyde process the 3,000-4,000-volt alternating current arc (50 ~) formed at the ends of water-cooled copper rods, is struck between the poles of a powerful electro-magnet, and is thus besides being rapidly intermittent, forced to take the shape of a disk of roaring flame, several feet in diameter. Through this flame air is blown, and at the temperature of some 3,000° C. which about one-fifth of it is said to attain, the nitrogen and oxygen combine to form nitric oxide. Eventually nitric acid, and finally basic calcium nitrate is produced. The capacity of the Notodden plant is 1,500 KW., and its yield 500 kilos of nitric acid per KW.-year, equivalent to a gross yield of over 700 tons in the year. This of course is far below the theoretical maximum efficiency of 157·5 grammes of nitric acid per KW.-hour equivalent to 1,400 kilos per KW.-year; but it will doubtless be largely improved upon in the future, and against a comparatively low yield efficiency one must consider the unusually favourable economic conditions under which electric energy can be generated in Norway, the present cost of power at Notodden being only $\frac{1}{10}$d. per unit. An enlarged 30,000-H.P. plant is now in course of erection at Svaelgfogg, a neighbouring waterfall, and ultimately a 200,000-H.P. plant is contemplated by the Norske Kvaelstop Company which owns the Birkeland-Eyde patents. It is expected that these further extensions will reduce the cost of power to $\frac{1}{16}$d. per unit.

The Bradley and Lovejoy process, which was being worked at Niagara by the Atmospheric Products Co., has not been in operation during the past year. The Frank process, for making the new fertiliser, calcium cyanamide ($CaCN_2$), by heating powdered calcium carbide to a temperature of 1,000° C. in a current of nitrogen, has been acquired by the "Societa di Produtti Ozotati," of Rome. A 3,000-H.P. plant, afterwards to be extended to 10,000 H.P., will shortly start operations at Biano del Orte. Unfortunately, nitrogen and not air must be used for this process. Prof. Guye has recently thrown out the suggestion that if, as Sir William Ramsay seems to think, the promising attempts now being made to fractionate liquid air, result in an economic and simple process for the production of nitrogen and oxygen, the Frank and the Birkeland and Eyde processes might advantageously be worked in conjunction, the former taking the nitrogen from the fractionated air, and the latter using the oxygen for enriching the raw material used by it, for such oxygenated air brings about a better yield of nitric oxide than does the use of ordinary atmospheric air.

Hypochlorites.—The interesting proposal made by Dr. F. W. Alexander to the Poplar Borough Council to electrolyse salt water and make use of the resulting hypochlorite solution as a disinfecting fluid for distribution for public and private use in the borough, will be fresh in the minds of most of our readers. It is not known yet what steps the Council have decided to take in the matter. The recommendation to adopt the Hermite type of cell, which is used at Netley and Ipswich, has met with some criticism from those who regard some of the other leading types with more favour. No fresh plants for treating sewage or polluted streams on a large scale have been erected during the past year, although negotiations for that purpose with Oxychlorides, Ltd., who own the Atkins process, are stated to be in progress. At present the use of hypochlorite is largely confined to hospital and household purposes; the Electrozone Co., working the Crawford patents, is making solutions to be so used. During the past year, the Electrical Bleaching Co., which had previously been experimenting at Nottingham, has developed into the British Hosiery and Electrolyte Bleaching Co., Ltd., for the purpose among other somewhat different things, of making hypochlorite by the Vogelsang process.

Possibly one day it will be found possible to substitute graphite for platinum electrodes; promising experiments are, as a matter of fact, now being made with that end in view; until this desirable change has been brought about hypochlorite will always necessarily be labouring under a great economic disadvantage. Another important problem that has considerable bearing on the commercial future of hypochlorite is how to make a stable solution in which the proportion of undecomposed salt present is low. These and cognate questions are at present being made the subject of investigations by electro-chemists. Mr. W. Pollard Digby initiated an interesting discussion on these problems of stability and efficiency of salt consumption before a recent meeting of the Faraday Society.

Electrolytic Alkali and Bleach.—As the profits to be derived from the sale of electrolytic bleach are still of a somewhat uncertain character, alkali manufacturers (electrolytic, of course) have lately been looking about for some new uses to which they can put their chlorine by-product. Thus, the Roberts Chemical Co., of Niagara Falls, make a pure hydrochloric acid, valuable because it is free from iron and arsenic, by passing the hydrogen and chlorine evolved in the cells over glowing coke; Mr. Acker, for the same reason, makes carbon tetrachloride and tin tetrachloride and oxide by means of his waste chlorine, the same is done in France and Italy; the Castner-Kellner Co. here, as has been already mentioned, make zinc chloride by the Swinburne-Ashcroft process. More recently A. E. Gibbs has proposed to produce chlorates and bichromates by means of the spare chlorine, thus: $6\ Na_2CrO_4 + 3\ Cl_2 = 3\ Na_2Cr_2O_7 + 5\ NaCl + NaClO_3$. The Townsend, a new diaphragm cell, is being installed at Niagara.

On the commercial side, in England, prospects are improving. The Castner-Kellner Co. declared a six months' dividend on September 30th last at a 4 per cent. rate, while the Electrolytic Alkali Co., on the strength of their £6,120 net profit, have been paying up their preference arrears. The report states that the process is working well, the products are selling well, and the plant is being added to—all very desirable features in an industrial undertaking. A less desirable feature was some internal differences on questions of policy, which it is to be hoped have now been amicably settled.

No notable progress in the chlorate industry during the past year can be chronicled. Some of the peroxides that we dealt with when discussing the alkali metals are now partly displacing chlorates as oxidising agents.

Ozone.—Here again there is nothing of any special interest to draw attention to. The ozoniser is still extremely inefficient, and until its efficiency can be very radically increased, one cannot hope for great progress in the use of ozone for water sterilisation. A great deal of experimental work is now being made in this direction. It has been suggested by Wommelsdorf that the influence machine, worked under suitable conditions, particularly of distance between the plates, would make an efficient ozoniser, and it would possess the special advantage of combining generator, transformer and ozoniser in one piece of apparatus. There are, of course, several considerable sterilisation plants at work on the Continent, and full descriptions of some of these have recently been published. One of the most important is that at St. Maur of the de Frise type, which treats filtered water from the River Maine. All the power required to sterilise 150 cubic metres per hour is provided by a 45-H.P. engine. The ozonisers work at 20,000 volts; they are worked off 80,000-volt transformers, the alternators being Mordey 110-volt machines. It is estimated that even a 1,000 cubic metre plant would require only 129 H.P. to work it. At

Ginneken, in Holland, a 16-KW. plant of the Schneller type is in use, treating 20 cubic metres of water per hour; the efficiency is low, being only 7 grammes of ozone per KW.-hour. The Vosmaer process, which has given satisfactory results at the River Vecht, a highly polluted stream in Holland, is going to be adopted in Philadelphia: this process is stated to have an efficiency of 15 grammes of ozone per KW.-hour. All reports of ozone sterilisation now agree as to the remarkable destruction of bacteria brought about by the treatment.

Calcium Carbide.—There is still, as far as one is aware, no longer any calcium carbide being made in this country, nor under present economic conditions is there any likelihood of the revival of the industry in England. The world's production for 1904, the yield of some 60 or 70 plants, is estimated to have been about 90,000 tons; existing plant being capable of manufacturing 150,000 tons. The production for 1905 was possibly over 100,000 tons. The Acetydone Manufacturing Co. just started at Niagara now turns out carbide bound and moulded in the form of sticks ("acetydone.") These can be exposed and handled without appreciable decomposition, and they allow of gas being generated and controlled with great ease and regularity. It is interesting to note that resistance furnaces have now established themselves as the standard type for carbide production under the best possible conditions.

The capacity of carbide furnaces still tends to increase; in the Darfo Works (France) furnaces of 1,200 H.P. capacity are about to be installed. Voltages have fallen from 60 to 30 or 40; the consumption of electrodes in the best types is now only 20 kilos per ton of carbide.

As in the case of other manufactures, where over-production has been the keynote for some time, new uses for calcium carbide and acetylene have been sought after recently. From the former, as already stated, much calcium cyanamide can be made. Acetylene is now in considerable demand in France and Belgium for the autogenous welding of iron and steel and other metals, at a cost only one-third that of other methods. At the Liège Exhibition there was quite a striking display of large oxy-acetylene blowpipes on view. Prof. Threlfall, in a recent address to the Birmingham section of the Institution of Electrical Engineers, points out that with silica tubes and rods (that can now be made from sand inside carbon tubes by means of electric heating) and oxy-acetylene blowpipes, it would be easy to make any kind of apparatus out of opaque silica. One great advantage of acetylene welding is that the metal is surrounded by a reducing atmosphere. The proportions recommended are 1 volume of acetylene to 1·7 volumes of oxygen, and the temperature at the centre of the flame is 3,000° C. Another possible and very interesting new use for acetylene is the manufacture of cyanides. Berthelot long ago showed that on sparking a mixture of acetylene and nitrogen prussic acid and carbon are produced. Muthmann, instead of a spark, uses a high voltage flame through which he blows a current of the mixed gases. He states that cheap hydro-carbons can be used instead of acetylene, and he is of opinion that the process is efficient enough to be made commercially possible.

Carborundum, &c.—The demand for the abrasive products of the Acheson furnace continues to increase steadily. The carborundum plant at Niagara has recently been increased by a new 1,500 KW.-unit; the present annual production is likely to be at the rate of about 4,000 tons a year. Now that alundum (artificial corundum) is competing as an abrasive with carborundum, however, it is probable that the latter will in future be largely used instead of silica, as the raw material for the manufacture of ferro-silicon.

An American company with $500,000 capital, has recently been formed for the purpose of producing manufactured articles, such as firebricks, crucibles, muffles, &c., from raw silixicon.

Artificial Graphite.—The uses to which artificial graphite is being put increase daily, and with the further development of the electric furnace, in which as terminals as well as electrodes, it now plays an important part, its consumption is likely to go on increasing in geometrical progression. The International Acheson Graphite Co. is now installing a 2,000-H.P. unit, thus doubling its previous capacity. This will enable it to produce in the near future nearly 2,700 tons a year. In 1904, out of a total value of $341,372 for all the graphite produced in the United States, $217,790 fell to the share of Acheson graphite. A new granular resistance material—or "resistor" as F. A. J. Fitzgerald has named such substances—called "Kryptol," is now on the English market, and is claimed to be particularly suitable for small resistance furnaces and for domestic and general electric heating apparatus. It is probably a mixture of graphite and amorphous carbon, with a suitable binding material: Augustus Voelker is the patentee.

Conclusion.—As the intention of this article was not to give an account of the present position of the various electro-chemical and electro-metallurgical industries, but merely to record any noteworthy progress that has occurred or been made public during the past year, there are, of course, several industries or applications that have not been mentioned at all. In such cases either there has been no change or progress specially calling for mention, or else the processes omitted, if existent at all excepting on paper, have been so jealously guarded by a protective wall of secrecy, that no information of any value—with the exception of patent specifications, which need not count — is available for purposes of publication.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

An Unbusinesslike Resolution.

You have already, I think, announced in your paper that an Electrical Exhibition is to be held in the Exhibition Buildings, Newcastle-upon-Tyne, during part of the months of March and April. The opening day is fixed for March 24th, and the Exhibition will run for one month.

From the support which has been given to it by the electric supply companies and the various contractors and engineering firms in this district and elsewhere, the Exhibition is likely to be thoroughly successful. Four first class bands have been engaged, and arrangements are well in hand for inviting the various local authorities, engineering and colliery societies to visit the Exhibition.

Throughout the negotiations which have taken place between the representative electrical manufacturing companies of the country and those responsible for the management of the Exhibition, it has been very marked that many firms would have been only too glad to have availed themselves of the opportunity this Exhibition affords for placing their manufactures before what one may call "an electrical public," for, as is well known, nowhere else in the country has electricity been so widely adopted as in Newcastle-upon-Tyne and the surrounding districts. Apparently many of the manufacturers would have exhibited, but for the ill-considered resolution under which many of them bound themselves, which was adopted by the Manufacturers' Association. That this resolution was ill-timed and ill-advised is becoming more and more apparent.

It has been said, and truthfully said, that the reason why the gas authorities are still putting up such a good fight against their electrical competitors, is that they are much more businesslike and progressive. There is no doubt that gas engineering firms would never have bound themselves to refrain from exhibiting at any Exhibitions of importance. Manufacturers of electrical machinery and apparatus are never likely to exhibit unless they can see some prospect of gaining advantage thereby. In their own interests, and in the larger interests of the electrical industry throughout the country, they should be free to exhibit or not as they think fit.

It must be remembered that there are numerous manufacturers not affiliated to the association who are not slow to take advantage of the absence of their more formidable competitors, whose wares, under ordinary circumstances, would be exhibited under the same roof. That this is so is exemplified in the case of the forthcoming Exhibition at Newcastle-upon-Tyne, the success of which, notwithstanding the absence of some of the better known firms, is assured.

No doubt the enterprise of the firms who have not been so short-sighted as to be bound by the resolution complained of, will reap its own reward.

Arnold B. Gridley.

Newcastle-upon-Tyne, *February 21st*, 1906.

The Single-Phase Induction Motor.

Referring to Mr. F. Creedy's letter on the above subject in your issue of February 23rd, I am sorry to hear that he has not met with success in his attempt to produce a variable speed single-phase shunt induction motor. His reference to suitably connected auxiliary coils in the axis D D is so vague that I cannot discuss this point or attempt to offer any suggestions for overcoming the difficulty which was met with. Mr. Creedy is also somewhat short in his estimate of the scope of my article; in due course he will become acquainted with the whole of it, and will then see that I specify some 21 ways in which the speed of a shunt motor operated from a single-phase supply can be rationally regulated; of these 13 at least are applicable to the shunt induction motor. I have, however, not enumerated all the possible solutions.

I do not know which theory Mr. Creedy had adopted as a basis for his experiments, it is evidently not mine, as I see by his remarks that I have, so far, failed to make myself clear to him. It seems very difficult indeed to satisfy everybody; those who have read the whole of my article have all expressed their particular satisfaction at the absence of diagrams and formulæ, while Mr. Creedy takes a rather early opportunity of expressing the opposite view. I believe, however, that a discussion seldom fails to throw additional light on any subject, and for this reason I welcome all criticisms.

In my article I have fully set forth my views relating to the E.M.F. (E R), and consequently need not go over the same ground again in reply to Mr. Creedy's remarks on this point.

Turning to his comments relating to the working or armature current, I hold that the latter can only be in phase with the E.M.F. (E T — E B) provided there is absolutely no self-induction in the armature axis, in which case the smaller the rotor resistance the better, but then we can neither reduce the self-induction nor the resistance to zero.

Mr. Creedy also seems to assume that E T and E B are exactly opposed in phase, this is not so; they are only *nearly* opposed in phase, as I have stated for instance on p. 204, line 24 from bottom. This apparently minor point is, however, of far-reaching consequence, and if I have not dwelt on it at length in my article, it is because I did not wish to encroach on the paper I am to read before the Institution of Electrical Engineers on March 8th. Under the normal working conditions of the shunt induction motor as heretofore designed, and assuming the rotor resistance to be zero, the working current could only lag by 90° behind the resultant of E T and E B, it could certainly not lag by that amount behind E B; this current would, however, be somewhat out of phase with the motor field. If Mr. Creedy's contention were correct, then both the output and the efficiency of such motors would increase with increasing rotor resistance. When reading my paper I will endeavour to state my views on this particular point as plainly as possible, and thus give Mr. Creedy a more satisfactory answer.

Coming to the last point of the letter in question, I see no difficulty in showing with the help of my theory how the no-load current of these motors is made up; I doubt, however, whether Mr. Creedy or anybody else can show by any reliable theory that the no-load current *must* always be twice the magnetising current. The proportion between the two varies greatly with the size and design, and one often comes across cases where the no-load current is only 1·5 times the magnetising current, whilst in others it is as much as 2·5 times the latter; the more general proportion is, I think, 1·7 : 1.

Apart from the magnetising current required to set up the transformer field in the axis C C, there are quite a number of losses to take into account which increase the watt component of the no-load current very materially; these I will now briefly enumerate. Beginning with the motor-field axis, there is the magnetising current in that direction to take into account; it would require no power to drive the latter through the field winding but for the losses it entails; these consist of copper losses in the field winding and hysteresis and foucault current losses in the path of the motor field. In order to overcome these losses the motor must exert at no-load a torque in excess of that which would be required to overcome the friction and ventilation losses only, since it has been shown that the motor *itself* generates by rotation in the transformer field all the energy necessary to excite its own motor field. The armature current in the axis C C will, therefore, assume a value which, in conjunction with the existing motor field, and taking into account the phase relation between the two, will give the torque required to cover the friction, ventilation *and* motor field excitation losses. This means an additional copper loss in the rotor along the armature axis and a correspondingly increased watt component of the stator no-load current. Finally, we have to add the copper loss in the stator winding and the hysteresis and foucault losses occasioned by the transformer field. When a commutator and brushes are used, they will be responsible for additional losses, as is well understood.

If Mr. Creedy will calculate *all* the losses I have indicated for any given motor, he will find that the calculated and observed values of the no-load current for that particular machine will agree closely enough. He will also find that the smaller the magnetising current in the transformer axis and the larger the losses, the better the power factor at no-load and generally the worse the efficiency.

Val. A. Fynn.

London, *February 24th*, 1906.

Overhead Construction.

I have to thank "R. D. D." for troubling to communicate from Sydney. His remarks about bases are particularly interesting to me, as they strengthen my impression that bases are unnecessary. The cogent reason for their use which he gives, a reason which was urged independently by a contributor to the discussion on a recent paper on overhead equipment, does not convince me that when a heavy cast-iron base is put up to defend the steel pole against the thoughtless attentions of the companion of man, it needs to be of a greater height than that indicated by the observed mean effective range. "R. D. D.," himself, says that a zinc sheet enwrapping the pole for a distance of 15 in. above the ground level is "an effective method of overcoming trouble of this nature," and I am prepared to accept this height as the result of careful research, which, for anything I know to the contrary, may apply also to the canine circumstances of this country.

Why then should we use bases of a height suitable for protection against the attacks of the large cat tribe and young elephants?

The question of draining a pole which is sunk 6 ft. below the surface, presents no considerable difficulty if that 6 ft. is filled with rubble capped with a sufficiency of cement.

The 4 in. to 5 in. radial thickness of concrete which "R. D. D." finds ample for holding a pole against pulls of 700 to 800 lb. compare favourably with the 7 in. to 9 in. to which our contractors are accustomed.

The galvanic trouble with the lead caulking of the joint at the top of the base arises only, as "R. D. D." states, when water is able to lodge between the lead and the skin of the pole, and I am glad to accept the view that I have exaggerated this danger. Similarly many gentlemen experienced in tramway work have been more fortunate than I in finding little deterioration of the hidden parts of poles when the bases have been removed, so that, in order to keep my point about bases as keen as possible, I am willing to give up all the objections to them, except the main and vital one, that they are useless extravagancies.

The paper mentioned above, together with the reply to the discussion thereon, contains sufficient answers to "R. D. D." on the subject of arcing wear.

I should like to thank "R. D. D." for a courteous letter, which helps me to keep alive a subject which needs far greater attention than it has obtained for some years.

Robert N. Tweedy.

Stourbridge, *February 26th*, 1906.

Modern Book Canvassing.

As I am not writing upon a technical subject, I do not wish to take up more space than necessary. I merely wish to sound a warning note to those pupils and assistants who may have to listen to the enterprising talk of travellers canvassing for orders for a certain electrical book.

I have nothing to say against the book; I have seen a friend's copy, but conclude that my collection of catalogues and Electrical Reviews answer my purpose. The warning is, to trust only 10 per cent. of the canvasser's alleged subscribers.

I was informed that the chief assistant and most of the staff (names all given) of a central station had subscribed to this book; but I found that actually only one of the shift engineers had subscribed.

Students can't be too careful in dealing with these canvassers, as they have a dodge of letting a fresh man face the music on the second round.

W. Lunn.

Lowestoft, *February 24th*, 1906.

Shift Engineers' Holidays.

I should like to call the attention of your readers to the extremely mean way in which shift engineers are treated in regard to their holidays, with the hope that it may lead to some beneficial improvements. There are very few people (even committemen) who really understand the trying conditions under which we work; most of us work eight hours a day throughout the year and get a paltry 14 days' holiday. It is true that we get so-called "week-ends off," once in three weeks, but few seem to realise that we make this up by working 12-hour shifts while the third man is away, so we get no holiday in the week at all—not even Bank Holidays. What seems to me to be so unfair is, that others engaged in the same profession, and with a similar status, only not engaged on shift work, should have the same holiday, when they get every Saturday afternoon and Sunday, not forgetting Bank Holidays.

Surely, considering the unconventional hours we have to work, and the responsibility placed in our hands, not forgetting the very small salaries that most of us have to work for, we are worthy of as much holiday as a labourer?

Shift Engineer.

How to Screw Conduits.

The question of standardisation of conduits is now receiving attention at the hands of the Engineering Standards Committee, who are undoubtedly the proper authority to deal with it. I feel sure that my action in treating the matter as being *sub judice*, and refraining from further comment on Mr. Schmahl's latest contribution will not be misinterpreted.

L. M. Waterhouse,
Director and General Manager,
The Simplex Steel Conduit Co., Ltd.

London, *February 27th*, 1906.

Consumer's Leakage Indicator.

The writer has a faint recollection of hastily reading some time ago in your journal amongst the columns allotted to "Trade Notices" a short description of a new patented leakage indicating apparatus that had been invented and put upon the market for use on consumers' installations, where such installations were supplied with current from a supply undertaking working on the continuous current three-wire system with earthed neutral.

It was, I believe, claimed for this apparatus that by its use the consumer could immediately ascertain for himself whether or not there was any earth leakage on his installation, together with an approximate idea of the amount of such leakage, and this, *mirabile dictu*, without necessitating the slightest interference with the continuity of supply.

In the event of any of your readers having had practical experience of this apparatus, any particulars of the same which they might care to give, either through the medium of your columns or direct, would much oblige.

J. E. Dawson.

Corporation Electricity Works,
West Hartlepool, *February 26th*, 1906.

Technical Teaching Salaries.

May I ask the attention of those of your readers who are thinking of entering the technical teaching profession. They will see by the appointment columns of your valuable periodical that appointments have just been made to the posts of junior demonstrators in Physics and Mechanical Engineering at Nottingham University College. The two gentlemen appointed are a D.Sc. and M.A. respectively. The salary in each case is £130 a year, and according to the particulars sent to candidates, workshop experience was a recommendation. Comment is needless, for the salary is not much above that of a scavenger in a district where gratuities are large. Might not the intending teachers choose some other profession, in which merit receives its due reward, and which is not so over-crowded? What can be said of those who can *accept* such gentlemen as the above at such a low salary?

Technical Teacher.

Thermal Efficiencies.

In reply to the letter of Mr. Alfred Bennis, appearing in your issue of last week, an 85 per cent. efficiency is certainly possible with most plants, and with most forms of mechanical stoker, if you understate to begin with, the thermal value of the fuel used. This is really the crux of the whole discussion, and my criticism was, therefore, very much to the point.

As regards the Darling calorimeter, Mr. Bennis would do well to refer to the reports named in my last letter before writing further epistles on its accuracy. I am not at all impressed by the reference to the tests made by the "eminent" authorities at the Universities of Manchester, Sheffield and Leeds. In the first place, I should require to know what type of calorimeter was used for these check tests, and in the second place, I should desire to know how much experience the man who was making the tests had of calorimeter work, before placing great reliance on the results obtained.

In the light of the reports I have already referred to, the very fact that the "eminent" authorities at Manchester, Leeds and Sheffield have supported the accuracy of results obtained by a type of calorimeter which Messrs. Gray and Robertson and Messrs. Brane and Cowan have found unsatisfactory, is not conducive to confidence in the accuracy of the results obtained by the former.

I know something of the work carried on in university laboratories, by demonstrators and students, for merely educational purposes, and perhaps if Mr. Bennis knew as much on this subject he would be more chary of quoting the results obtained.

John B. C. Kershaw.

Waterloo, *February 26th*, 1906.

Paint Remover.—A correspondent inquires the name of the maker of a fluid paint remover.

Fire at Charlton.—On Tuesday morning early a fire occurred at the cable factory of Messrs. Johnson & Phillips, Ltd., at Victoria Works, Charlton, S.E. Serious damage to a portion of the cable shops resulted. Messrs. Johnson & Phillips expect to restart the damaged shops very soon, and meantime they are making arrangements to execute all orders without delay. The remainder of the cable works, electric power and telegraph works are in no way damaged, and work is going on as usual. The works were insured.

LEGAL.

Mayor and Corporation of Bournemouth v. the Poole and District Electric Traction Co.

This action and counterclaim came before Mr. Justice Joyce in the Chancery Division on 21st ult.

Mr. Hughes, K.C., appearing for the plaintiffs, said the case raised points involving substantial sums of money in connection with an agreement executed between the parties for the sale and purchase of the Electric Co.'s tramways. It was agreed that the Corporation should pay the fair market value as a going concern of the Poole undertaking of the company, certain parliamentary costs and expenses, and the fair market value of the Christchurch undertaking. The appointed day for the completion was December 31st, 1903, but the actual completion did not take place until June 15th, 1905. It was arranged that the arbitrator should base his calculations on the balance-sheet of the company for the year ended December 31st, 1903. The award was made on December 21st, 1904, under which the Corporation had to pay the company £112,000. The action, as originally started, was for specific performance immediately after the tender of the purchase money; possession, however, was given shortly afterwards, and the Corporation now gave up the question of damages for the delay on the company giving up another matter of compensation. Several questions had arisen on the balance-sheet, but many of them were of minor importance, and had been disposed of by concessions on either side. What the company now claimed to be paid was the amount of four items in the balance-sheet—temporary loan from bankers secured by a charge on the company's undertaking, £7,000; sundry creditors, including the British Electric Traction Co., £4,558; depreciation and reserve fund, £4,253; and profit and loss account, £6,628.

In the result, his Lordship decided that the items of £7,000 in respect of banker's loan, and the £4,558 sundry creditors, should be referred to an accountant as referee to make a special report on the findings as to fact. His Lordship reserved judgment on the question of the parliamentary deposit, sundry debtors and cash in hand.

Priestley v. Marylebone B.C.

This matter, in which the plaintiff sought to restrain nuisance by noise occasioned by the defendants' electric works was mentioned again before Mr. Justice Warrington on Friday. Counsel stated that the parties were conferring, and the motion would stand over generally.

Stevens v. Electrical Heating Corporation.

In the Westminster County Court on February 22nd, Mr. H. E. Stevens sued the Electrical Heating Co. to recover the sum of £5 12s., the cost of an electrical sand bath which he purchased from the defendants, and with which he received a guarantee that it would boil a pint of water in 10 minutes. The apparatus had been tested in the presence of one of defendants' representatives, and it had taken 19 minutes to boil the water.

Defendants' Manager said the apparatus had been tested under improper conditions. The flask which was used by the defendant to hold the water was too large, and did not fit the machine properly. He was quite willing for the apparatus to be tested by any electrical firm, and he was convinced that, under proper conditions, it would boil the water in the stipulated time.

His Honour adjourned the case, in order that the machine might be fairly tested.

A St. Helens Tramway Claim.

At the Liverpool Assizes on Saturday and Monday, Mr. Justice Bray and a special jury heard the claim of Mrs. Isabella Williams against the New St. Helens and District Tramway Co. and the Mayor, Aldermen and Burgesses of St. Helens, for damages by reason of the death of her husband by the falling of a trolley head and standard on an electric car on which he was travelling. The case was heard at great length, and elicited some interesting theories in explanation of the falling of the trolley head.

Mr. Frank Wright, consulting and electrical engineer, thought that the groove of a trolley wire "ear" ought to be tinned the full length and then "sweated" on to the line wire until the wire and "ear" became one. He found that in the case the car had been soldered only at each end. He did not think the head had become detached owing to the head pin being fixed too tightly.

Mr. Fredk. Macdonald Evanson, civil and mechanical engineer, thought that if soldered wires were used there ought to be a daily inspection. Trolley heads were difficult to adjust, but they ought to be fixed so as to be able to come off without pulling up the standard.

Mr. Taylor, K.C., for the defence, submitted that the accident occurred through the trolley wheel leaving the live wire at the curve before the "car" was reached.

At the hearing on Monday, Mr. Thomas Davies, engineer, Widnes, expressed the opinion that when the car came round the curve the swinging of the wire caused part of the attachment of the "car" to go; the wire thus became arched, and the trolley head caught in the car. It was not difficult to adjust the ordinary detachable trolley head, but the judgment necessary to adjust it was frequently wanting.

Mr. Wm. Hutchings, general manager of the defendant company, said the B. of T. had approved of the trolley head in question, and he was not entitled to alter it in any way.

Mr. E. M. Hollingsworth, electrical engineer to the Corporation of St. Helens, was of the opinion that the trolley left the wire on leaving the curve, and the head, being damaged, caught the wire at a kink.

(To be continued.)

The Cooper Patent Anchor Railway Joint Co., Ltd., v. The London County Council.

This case came before Mr. Justice Swinfen-Eady in the Chancery Division of the High Court on Tuesday. Plaintiffs, who carry on business in Leeds, claimed an injunction to restrain the defendants and their agents from infringing the plaintiffs' letters patent No. 23,578 of 1898 and No. 14,941 of 1899. Damages were also claimed. Defendants in 1904 used the plaintiffs' patent rail joints in the construction of the Brixton electric tramways. They disputed the validity of the patent, alleging it had been anticipated by the publication of:—

1. United States letters patent 21,406 of September, 1858, granted to E. Benedict.
2. Letters patent 67,626 of August 13th, 1867, granted to Joseph Anthony.
3. Letters patent 1,303 of 1870, granted to Macnair.
4. Letters patent 2,606 of 1872, granted to Bradford Leslie.
5. Letters patent 4,537 of 1877, granted to Levick and Winby.
6. Letters patent 3,060 of 1880, granted to De Feral.
7. United States Patents 280,654 of July, 1883, and 297,283 of April, 1884, granted to Morgan, jun.
8. Letters Patent 17,128 of 1886, granted to Marshall.
9. United States Patent 474,126 of May, 1892, granted to Heath.
10. Letters patent 10,692 of 1894, granted to Ibbotson.
11. United States Patent 515,478 of February 24th, 1894, granted to Meyer.
12. United States Patent 522,349 of July 3rd, 1894, granted to Meyer.
13. Letters Patent 20,983 of 1896, granted to Spaulding.
14. United States Letters Patent 561,266, dated October 13th, 1896, granted to Wrightson.
15. United States Letters Patent 573,980 of December 29th, 1896, granted to Jennings.
16. A paper entitled "Modern Tramway Construction," published in the *Transactions* of the Society of Engineers for 1879, at pages 183 and 185.
17. Specifications for tramways to be constructed in Coventry and in Norwich, prepared in 1897 by Mr. J. E. Winslow, technical manager of the New General Traction Co., Ltd.

Defendants further stated that the alleged invention had been used by persons at the places and dates as follows:—

1. Messrs. Kincaird at Leeds in 1872; at Sheffield in 1873.
2. Messrs. Winby & Nevick at Nottingham in 1878.
3. The New General Traction Co., Ltd., of Bishopsgate Street Within, and by Messrs. R. W. Blackwell & Co., of 39, Victoria Street, Westminster, on the tramways at Coventry since January, 1898, and at Norwich on the tramways since June, 1898.

Defendants further said that, having regard to the published knowledge at the date of the plaintiffs' patent with respect to methods of jointing rails of railways, electric tramways, &c., by bolting, riveting, or welding a short length of inverted rail or T iron to the undersides of the end of the rails to be jointed and sinking the same in earth or concrete, no invention was required to produce the real joints described in the plaintiffs' claim, and that the letters patent was invalid for want of subject matter.

Mr. Cripps, K.C., Mr. Bousfield, K.C., and Mr. Walter appeared for the plaintiffs, and Sir Robert Finlay, K.C., and Mr. J. C. Graham for the defendants.

Mr. Cripps, K.C., in opening the case, said the invention related to a joint or method of jointing rails where a tramway or light railway was laid on a bed of concrete. In modern tramway construction the rails were laid on a bed of concrete. As soon as that method of construction became general, and more particularly after the introduction of electric cars, which were of great weight and went much faster than the ordinary horse cars, one of the main difficulties was found to be how to join the rails to one another so as to get a joint satisfactory both as regarded cost and as regarded life. It was an extremely difficult problem in the view of tramway engineers, and Mr. Cooper was the first to solve it. Since Mr. Cooper's invention substantially all tramways had been laid with joints of the character described in the plaintiffs' specification. The invention had been nearly universally adopted. It was one of immense utility, and removed a difficulty which had been in the way of tramway engineers for a great number of years. The extensive use of the joint had led to Mr. Cooper and the company securing the advantage of a large number of royalties. Excepting a case at Swindon, the present was the only instance where the right to royalty had been refused and the patent rights called in question.

(To be continued.)

BUSINESS NOTES.

New Publications.—The first number (March) of a bi-monthly journal bearing the title *Concrete and Constructural Engineering* has just been received. It is published at 57, Moorgate Street, E.C., and the price is 1s. net. A number of interesting and well-illustrated articles on concrete, re-inforced concrete, and constructional engineering generally are given in this issue, which should make a good impression on those who take a particular interest in this important department of engineering work.

The Steam Car and Electromobile Review is a new monthly publication of which the first number (February) has been issued. Among the matters of electrical interest is a signed article by Mr. Carl C. Oppermann on "The Electric Carriage: its Construction and Management." Electric vehicles at the New York shows are illustrated, and other features are "Accumulator Jottings" and notes on "Electromobile Garage Organisation." The price of the journal is 3d., and its offices are at 4 and 5, Gough Square, Fleet Street, E.C.

American Electrical Exports during 1905.—The *Electrical World* of New York in its issue just to hand gives a few interesting facts regarding American electrical exports, and the destinations for which they were bound, during last year. "The exports of electrical appliances, including telegraph and telephone instruments, reached a total of $5,648,435; and the exports of electrical machinery amounted to not less than $7,409,242. The aggregate is $13,057,677. This compares with a grand total in 1904 of $11,039,758, or a gain of $2,017,919, or about 20 per cent. Such a condition of affairs is healthy and encouraging, and shows that the export of electrical goods from America can be made successful if steadily and intelligently pushed. Part of the increase may be due to the higher cost of material, such as copper, but the figures as a whole reflect genuine gains. This is the more notable because so many American electrical manufacturers have factories or arrangements for the production of their apparatus abroad. An analysis of the returns shows that England and her colonies remain our good friends. Of electrical machinery British North America took $2,023,914; the United Kingdom, $885,095; British Australasia, $252,028; British Africa, $161,449; British East Indies, $109,944. Wherever the English flag flies a similar welcome awaits our goods. We also have generous patrons in Japan to the tune of $1,239,878, and excellent customers in Mexico to the extent of not less than $1,057,023. South America generally was good for about $500,000."

Tramway Lifeguards.—Messrs. Hudson & Bowring, Ltd., of Manchester, have received through the Brush Co. an order for the fitting of 16 cars for the Croydon Tramways with their lifeguards, also further orders for Darwen, Derby, Mansfield, and the Manchester Corporation Tramways.

Parliamentary.—Petitions.—A further large number of petitions have been lodged against electrical Bills originating in the Upper House.

Standing Order Proofs.—On Monday, Standing Orders were found to have been proved in the case of the following Bills:—Derbyshire and Nottinghamshire Electric Power Bill; Metropolitan Railway; South Wales Electric Power Distribution Co.; City of London Electric Lighting; Twickenham and Teddington Electric Supply; West London Electric Undertakers' Association; North Metropolitan Tramways and the Metropolitan District Railway.

On Tuesday the necessary steps were found to have been complied with in the case of the London Electric Supply Corporation; Charing Cross, West End and City Electricity Supply; and the Baker Street and Waterloo Railway Bill. Proofs were also received in the cases of the Ardrossan, Saltcoats and District Tramways; the Dunfermline and District Tramways; and the Falkirk and District Tramways Extensions, but the consideration of opposed points was postponed.

Dance.—The second dance of the season of the staff of Messrs. W. T. Glover & Co., Ltd., took place on February 23rd at the "Academy," Brunswick Street, Manchester.

Messrs. Callenders' Cable Co.—It is reported that the directors of this company have been considering the advisability of setting up cable works in Germany. Mr. Callender, in reply to inquiries, is reported to have stated that there was some foundation for the rumour, but no decision had been come to. The firm had had to abolish their night shift and to discharge some of the day men. Their Continental trade had entirely ceased, owing to the prohibitive tariffs of protected countries, and for that reason they had considered the possibility of opening works in Germany. Reports had been made as to possible sites, and plans had been prepared, but that was as far as the matter had gone. "It was evident that if they wanted their foreign trade back they must open works abroad, unless tariff reform was carried into effect. If the firm went to Germany they would not close their works at Erith, but for the first few years they would have to feed the German factory. The firm did not wish to go to Germany if they could help it."

Japan.—The *Anglo-Japanese Gazette* says that the profit earned by the Tokio Electric Railway Co. for the second half of last year, after providing for working expenses, amounted to Y369,256. Rates and taxes took Y49,526, dividend at the rate of 7 per cent. per annum Y183,750, bonus at the rate of 3 per cent. per annum Y78,750, making the distribution at the rate of 10 per cent. per annum. Y18,462 is placed to reserve fund, and a like amount to special reserve account for equalisation of dividends.

For the six months ended December 31st the net profit earned by the Keihin Electric Railway Co. amounted to Y56,476, to which was added the sum of Y310 brought in from the previous half-year. The directors pay a dividend at the rate of 8 per cent. per annum, absorbing Y51,000, placing Y2,823 to reserve, gratuities to employés Y2,518, leaving a balance of Y444 to be carried forward to the June account.

British Trade with Persia.—The *Times* says that Colonel Gleadowe-Newcomen's report on the commercial mission which travelled through South-Eastern Persia during 1904-5, states that during his journey of some 2,000 miles he found British influence and prestige to be not only predominant but a real power for good. On the other hand, he points out that British trade with Persia is not as flourishing as might be desired; it has expanded but little during the last 15 years, and recently has exhibited a slight decrease. Russia's trade for the year ended 1904 was considerably over 5½ millions sterling, while British trade was less than half that amount, in connection with which it is to be remembered that the trade of Russia lies with the richest parts of Persia, that it is carefully nursed and supported by artificial aids, and that it is favoured by comparatively easy means of communication between the two countries. It is urged that British Consuls would do well to follow foreign example by concerning themselves with the advancement of trade, as well as with political questions, and that a greater degree of unity is needed in the system of representing British interests in Persia.

Municipal Electrical Contracting at Norwich.—At the meeting of the Norwich T.C. on February 20th, the Mayor (Mr. E. T. Boardman) moved that an order be passed requesting the several departments of the Corporation to place in the hands of the Electricity Committee all work required with respect to E.L. fittings, wiring, maintenance, &c. Mr. Wild, in seconding, said that the electricity works were as much part and parcel of the corporate work as were those of the Executive Committee. The Committee did not want to make anything out of the work, but they thought that the city having got its own plant, the electrical needs of the Corporation should be supplied therefrom. The Electricity Committee declined to tender in competition with the tradesmen, but they were prepared to give an estimate for any work, if they alone were asked to do so. Mr. Day said it was not fair to the Electricity Committee itself, or to outside tenderers to ask the Committee to compete with private firms. He agreed with the principle, but was he to understand that the Council as a body agreed that any department of the Council should not be required to compete with outside firms? Mr. F. Jewson said the resolution was a far-reaching one, and he asked, if it was passed, was it to be taken as an order to every committee that anything they wanted done in the way of electrical work, without any qualification whatever, was to be placed in the hands of the Electricity Committee? Mr. Crotch also asked with respect to the lighting of the Continuation Schools, if the Education Committee was to be placed entirely at the mercy of the Electricity Committee. If so, the former would have no means of telling whether the price charged was cost price or not. Mr. Holmes did not think the Electricity Committee ought to enter into competition with the tradesmen of the city, but the Corporation ought to patronise "their own shop." The Mayor's resolution was adopted.

Liquidations.—New British Engineering Co., Ltd.—This company is winding up voluntarily.

Crystal Palace District Electric Supply Co.—This company is winding up voluntarily, with Mr. James Gray, of Dashwood House, E.C., as liquidator.

Peter Pilkington, Ltd., Bamber Bridge.—A final dividend of 5s. in the £ is payable at 3, Winckley Square, Preston, to those creditors electing same in lieu of shares.

Bankruptcy Proceedings.—An order was made on February 20th at the Wandsworth Court against A. P. Jones and C. Hellyar (A. Parker & Co.), electrical engineers and contractors, of Upper Richmond Road, East Sheen. First meeting to be held at 132, York Road, Westminster Bridge, March 8th; public examination at the Court House, Wandsworth, March 22nd.

Catalogues and Lists.—Messrs. Laurence, Scott and Co., Ltd., Norwich.—Copy of 1906 price-list of semi-enclosed motors. A general specification is given, also tabulated data showing B.H.P., speed, code words, weights and dimensions, list of spares, and prices for low and high voltages in general use. Particulars of starting switches also appear. The firm has lately increased its stock of parts held in readiness, so that speedy delivery can be given for any windings shown in the list.

Messrs. Alfred Herbert, Ltd., Coventry.—New catalogue (Section "T") fully describing and finely illustrating their automatic spur-gear cutting machines and bevel gear shaper. Detailed drawings, together with instructions for operating, and tables of cotangents and change wheels for dividing are given.

The Howard Conduit Co., Ltd., Trafford Park.—Booklet, which by means of some excellent half-tone illustrations and some brief descriptive notes, imparts instructions for laying and jointing Howard patent troughing. It is claimed that if these instructions be carried out, a length of trough welded from end to end and perfectly solid and homogeneous will result, and it will be so ductile that subsidences will not affect the utility of the system. The company will send copies of the publication on application.

The Western Electric Co., North Woolwich.—Hanging wall calendar with monthly tear-off slips around which a number of views of the works and the company's manufactures are arranged. A complete calendar for 1906 forms part of the design.

Messrs. Mather & Platt, Ltd., Manchester. — Illustrated pamphlet describing the Zoelly steam turbines, which are manufactured at the Salford Ironworks. The half-tone pictures show turbo-electric plants at Mulhausen electricity works, Johannesburg, and Nonnendamm, Berlin. We understand that there are at present at work, or under construction, Zoelly turbines aggregating over 72,000 h.p. Full details of the construction, and of some recent results of test runs, appear in the pamphlet. A loose list contains some suggestions showing the class of information that should be sent by inquirers.

The District Electric Co., Berry Street, Wolverhampton.—Small pamphlet relating to their electrically driven propeller fans, giving particulars and prices.

The Premier Accumulator Co., Military Road, Northampton.—Illustrated catalogue of the Premier accumulators, giving particulars and drawings of the double interlocking grid, showing how the paste is locked in one unbroken piece throughout the plate, also results of a five months' test. Working instructions are included. The central station, ship lighting, train lighting, traction, ignition and other types of the Premier accumulator are all detailed in tabulated form, prices being stated in all cases. The catalogue has a thumb index to the different sections.

The Consett Iron Co., Ltd., Consett.—Recently issued booklet bringing before the reader the firm's various manufactures in steel and steel-chequered plates, pig-iron, coke-oven by-products, shearings, and sectional steel, &c. A few handy tables and some pages for memoranda purposes appear at the end.

Messrs. Elliott Bros., Lewisham.—Two new pamphlets: T.S. 58 fully describing Ewing's permeability bridge and giving instructions for its use; and A.C. 60 describing current transformers and giving prices of the same.

Trade Announcements.—Mr. Thomas Hill-Jones, charcoal manufacturer, notifies that he has moved from Eagle Wharf Road to more extensive and modernly-equipped premises at "Invicta" Mills, Bow Common Lane, E., for the manufacture of charcoals, bone ash, lamp black, plumbago, ivory black, &c.

Mr. Harry Wilson and Mr. Louis J. Wolf have purchased the business of the Webster Electrical Engineering Co., Ltd., Thornton Road, Bradford, and are continuing the business at the same address under the style of the Wilson-Wolf Engineering Co., Ltd., manufacturing dynamos and motors, and their accessories, also engineering work generally. Mr. Wilson was formerly with Messrs. Ferranti, of Hollinwood, and Mr. Wolf was assistant to Messrs. Talbot & Stevenson, consulting engineers, of Westminster. Mr. Webster, of the former company, has been retained as works manager and designer.

Book Notices.—*Journal and Record of Transactions* of the Junior Institution of Engineers. The Institution is to be congratulated on the production of a *Journal* in monthly parts, in which its doings, sayings and intentions will be recorded. The principal feature of the first issue is the presidential address of Mr. Dugald Clerk on "The Problem of the Gas Turbine"; the annual general meeting, two visits, and minor matters are recorded. Mr. W. T. Dunn, secretary, is the editor.

Continuous Current Armatures: their Winding and Construction. By C. Kinzbrunner, A.M.I.E.E. Harper & Brothers. This is a little book of some 78 pages, and is divided into three chapters. In Chapter I. there is the usual introduction as found in most other books dealing with dynamos. A wire is shown cutting lines of force, which pass from the north to the south pole, in air presumably, without any spreading. Then it is stated $E = B\,l\,v\,10^{-8}$, according to "a fundamental law." No law is, however, stated, and the units for B, l and v are not referred to. The "homopolar" dynamo is next dealt with, and after showing that with B in air (?) as great as 15,000, and a conductor equal to one metre length moving with a peripheral speed of 30 metres per second, the E.M.F. is *only* 15 volts. The author then states that this voltage is "much too small for most purposes," which would lead the reader to imagine that "homopolar" machines are of no use. However, a little further on it is stated that "homopolar machines have certainly a great future in connection with steam turbines." Nothing further is said regarding the calculation of E.M.F. in armatures, although in the following pages the usual commutated sine curves are shown. Next follow the usual ring and drum types of armatures, and the usual equations as found in standard works on the subject are stated in a somewhat bare and scrappy manner. Chapters II. and III. on the construction of drum windings and core, &c., are very meagre. To some students this book may be of use in giving them an elementary idea of how windings are arranged, but the student will look in vain for a single worked-out practical example of armature design. There is also no discussion of questions of economy, of commutation or heating of the armature, although we are informed that "owing to the exposure of the cylindrical surface of a slotted armature, the cooling is facilitated."

The Engineers' Pocket Directory.—French-English. By M. Lvoff. London: Percival Marshall & Co. Price 1s. 6d. net.—In the short time that this little book has been in our hands, we have had occasion to refer to it several times, and in each case the result was satisfactory. Its contents relate to mechanical and electrical engineering, motor-car building, &c., and by the omission of many of the words which are practically identical in both languages, space has been found for a large number of technical terms in small compass. Perhaps this process has been carried too far; for instance, the word *machine* is not to be found, so that the French equivalent of "steam engine" (*machine à vapeur*) is absent—surely a remarkable omission from an engineering dictionary! The English spelling, too, is not above criticism; for example, "waggon," "focussing," "tyre" have caught our eye. On the whole, however, our verdict is that this is an excellent and extremely useful little volume.

"La Télégraphie sans fils." By I. Van Dam. Amsterdam: Scheltema & Holkema's Boekhandel. 5s.

"Inaugural Address." By Mr. John Gavey, C.B. Delivered before the Institution of Electrical Engineers, November 9th, 1905. Excerpt from the *Journal* of the Institution.

"*Journal* of the Western Society of Engineers." Vol. X., No. 6, December, 1905. Chicago: The Society. 50c.

"The American Institute of Architects' Quarterly Bulletin." October, 1905, Vol. VI., No. 3. Washington, D.C.: The Secretary.

"The Physical Review." Vol. XXII., No. 2, February, 1906. Lancaster, Pa., and London: The Macmillan Co.

"Modern Buildings: Their Planning, Construction and Equipment." By G. A. T. Middleton. Vol. I. London: The Caxton Publishing Co. 10s. 6d. net.

"Die Abstimmung Funkentelegraphischer Sender." By A. Slaby. Part II. Berlin: Julius Springer.

"Prospectus of the Working Men's College, Melbourne, for 1906." Melbourne: The College, Latrobe Street

"Motor-Car Mechanism and Management." By W. P. Adams. Part I., "The Petrol Car." London: Chas. Griffin & Co.

"Electricity Meters." By H. G. Solomon. London: Chas. Griffin & Co. Price 16s. net.

Consular Notes.—Brazil.—The American Consul at Rio de Janeiro, reporting on the competition of German and American capital in Brazil, states that one of the large operating companies is the Rio de Janeiro Tramway, Light and Power Co., which has acquired possession of a large number of the local tramway and lighting systems. This company was incorporated in Canada in 1904, under the provisions of the Canadian Companies' Act, the head office being in Toronto. The capitalisation consists of $25,000,000 share capital and $25,000,000 debentures. The company was organised by a group of American and Canadian capitalists, most of whom are associated in similar enterprises in Canada and the United States, including the Sao Paulo Tramway, Light and Power Co., the Mexican Light and Power Co., the Trinidad Electric Co., the Habana Electric Co., the Toronto Railway Co., and the Montreal Railway, Light, Heat and Power Companies, &c. Wm. McKenzie, Frederic Nicholls, Sir Wm. C. Van Hoorne, F. S. Pearson and W. L. Bull are among the officers of the company. The purpose of the company includes the development of water-powers, and the utilisation of the same in the form of electric energy in Rio de Janeiro and other places. The company has already acquired two large waterfalls, one on the River Parahyba, a distance of about 80 miles from Rio de Janeiro, capable of producing about 100,000 h.p., others on the River das Lages and streams in the vicinity, about 50 miles from Rio de Janeiro, capable of producing 40,000 h.p. These latter the company is now developing, and expects to have power from the same in Rio de Janeiro within six months, although probably two years will be required to complete the development. It is estimated by the company, after a careful canvass of the city, that there is a present demand for 25,000 h.p. This, it is expected, will be considerably increased as the advantages of the use of electric power become fully demonstrated. The company has acquired the "Carris Urbanos," "Sao Christovao," "Villa Izabel" street car companies, and bas, it is understood, also a large interest in the "Carioca Co.," which operates the electric line from the centre of the city to Santa Thereza These comprise all the street car companies in Rio de Janeiro, besides the "Jardin Botanico" Co., which operates in a separate zone. The Carris Urbanos and the Sao Christovao Cos. have animal traction. Prior to the acquisition of the Villa Izabel Co., a considerable part of which is still operated by animals, the electrification of the lines had been commenced, and several are now electrically operated. It is the intention of the new company to immediately commence the transformation of the whole system, which, it is expected, will be completed within two years. The Carris Urbanos, Villa Izabel and Sao Christovao Cos. have now 125 miles of track; this will be increased in the transformation. The concessions of these companies vary from 30 to 50 years, with monopoly of zone. The new company is applying for a concession unifying all the existing zones. The company has also acquired the Société Anonyme du Gaz de Rio de Janeiro, which, under its concession from the Federal Government, controls the illumination of the city until the year 1945. At present there is a small amount of electric lighting from steam plants operated by the company. The new company is applying for various modifications in the existing concession. The company has also a concession from the Municipality of Rio de Janeiro, which includes a monopoly for the distribution of electric energy for power purposes until the year 1945, after which date the concession continues for a longer period without monopoly. The company has also recently acquired the property of the Rio Telephone Co., the business of which has heretofore been conducted by Siemens & Halske. The telephone concession includes a monopoly for a period of 30 years.

Greece.—The United States Consul at Athens reports that the Greek Electric Co., grantee of the Thomson-Houston patents, is interested in all electric lighting and traction enterprises in Greece. It owns electric stations in Athens and Piraeus, and has given concessions for the lighting of Syra, Patras, Argostoli, Chalcis, &c.

Canada.—The American Consul at London, Ontario, thinks there is a good field in his district for the sale of material for electric

tramways. He writes: "In this active, enterprising, thickly-populated part of the Dominion, where factories flourish and where the best of local markets exist, there is an important feature of modern commercial and industrial life which is notably lacking, and that is interurban electric roads. The towns and cities are supplied with good electric lines, but there are few interurban lines in Ontario. In this consular district there is one completed road, some 12 miles in length, between the towns of Woodstock and Ingersoll, and a line some 30 miles in length under construction, running from this city to Port Stanley, on Lake Erie, but I know of no other lines in Western Ontario, except the line from Windsor to Amhertsburg; and yet the entire country in every direction is thickly populated and filled with thriving towns and villages. London is the industrial centre, the market for all this territory, extending for some 60 to 100 miles in every direction. I know of no better or more enticing field anywhere for interurban roads than in this consular district."

Argentina.—The American Minister at Buenos Ayres reports that the Argentine Government has passed a law providing for the construction of underground railways in Buenos Ayres. Under the provisions of the Bill the municipality will be authorised to concede the construction and exploitation of a system of underground electric railways for the service of the city and such other branches as may in succession be deemed advisable. The terms of the concession are as follows:—

1. The contracting party shall construct the works at its own expense and in accordance with the plans approved by the executive.
2. The contracting party shall also pay for all lands expropriated for tracks, stations, shops, &c.
3. The contracting party shall administer and exploit the lines at their own expense and risk for a period of not more than 40 years, at the end of which time they, with all their tracks, stations, shops, rolling stock, &c., shall become the property of the municipality.

As in the case of other similar projects, all material intended for the construction and exploitation of these lines is to be admitted duty free. It is reported that German capital is already interested in this matter, which is said to be one of great importance and promise.

For Sale.—The Edinburgh Corporation is inviting tenders for the purchase of certain copper steam pipe bends (weight of copper 6 tons). The Exeter Corporation Electricity Department is offering for sale certain plant (including 100-kw. and 250-kw. steam alternators) at its old generating station. See our advertisement pages for particulars.

LIGHTING and POWER NOTES.

Birkenhead.—Messrs. Cammell, Laird & Co. are constructing new works at Tramere Bay, and electricity is to be used throughout for driving purposes, &c. A 4,000-h.p. Mond gas plant is now being put down to drive the generating plant.

Blackrock (Dublin).—A proposition to form a syndicate for the public lighting of the town by electricity has been adopted by the U.D.C., the promoters being required to pay the cost of the new order and that of the old one already obtained.

Bradford.—The new scheme resolved upon a year ago for extending the supply of electrical energy to consumers throughout the central area of the city is approaching completion. In addition the supply for traction purposes is also being increased. High-tension cables are being run to two sub-stations which are being established at Thornbury and Ordsal Top, with the object of supplying the outlying portions of the Manchester Road and Leeds Road sections of tramway. The energy carried by these cables will be stepped up to 6,500 volts, and at the sub-stations stepped down again to 500 volts.

Brighton.—Dissatisfaction has been expressed in regard to the maximum demand system of charging for supply, and upon the recommendation of the resident engineer, but against that of Mr. A. Wright, the Council's consulting engineer, the Electricity Committee has resolved to supply on an alternative flat rate of 4d. per unit. Certain consumers now supplied on the time switch system at 1d. per unit are to be notified that this rate is to be stopped.

Continental Notes.—Italy.—A concession is to be obtained for permission to erect a hydro-electric plant on the River Tanagro (Salerno) for energy for lighting and power purposes.

A newly formed local company is to establish an electricity undertaking in the town of Ovada.

La Società Elettrica ed Elettrochimica del Caffaro, with a capital of £160,000, is to put down a power plant on the River Caffaro, to establish works for the electrolytic manufacture of caustic soda and other products.

France.—According to a French contemporary, the Société d'Electricité de Paris has constructed new works at Saint Denis. The works have been put into operation; the plant includes four Brown, Boveri-Parsons turbo-alternators of 5,000 kw. each, and it is understood that the Société has ordered six additional sets of the same power. It is expected that the whole system will be put into operation in the year 1907.

Spain.—The municipal authorities of Campos (Palencia) have decided upon the lighting of the town by electricity.

A concession has been granted for a hydro-electric plant to be erected on the River Las Botijas at Cucoas de Provanco for electric lighting and power purposes.

Dublin.—On the 13th ult. Mr. P. C. Cowan resumed the inquiry, which was adjourned in December last, into an application of the Corporation to borrow £100,000, among other items, for extending the electric lighting system.

A report recommending the extension of the electric lighting system from the city area to Clontarf has been adopted by the Corporation.

Dundee.—The T.C. has instructed the electrical engineer to prepare plans and specifications for a new generating station, to report as to a suitable site, and thereafter, if deemed necessary, to call in an expert.

Exeter.—The electrical engineer has submitted estimates for the additional machinery required to deal with the proposed extension of the tramways along Alpington Road, and with the extensions likely to be required in the near future within the city, making a total sum of £15,500, for which borrowing powers are required, and the Committee has resolved that application be made to the L.G.B. for sanction to borrow that amount.

Falmouth.—A start has been made with the erection of the electricity generating station.

Harwood.—The U.D.C. has received from the B. of T. an intimation that it is proposed to revoke the Rishton, Great Harwood and Clayton-le-Moors E.L. order.

Lancashire.—On the 26th ult. a meeting was held in the Manchester Town Hall of the Executive Committee of the Conference of Boroughs and Urban Districts in the area of the Lancashire Electric Power Co. A statement which had been prepared in opposition to the company's Bill in Parliament was considered and finally approved, and copies were ordered to be printed and distributed. Manchester and Salford, while sympathising with the boroughs and urban district authorities affected, will not take part in the joint opposition, but will oppose on their own behalf. Similarly, Liverpool, Bootle, Stockport and Bolton regard the circumstances as warranting them in extending sympathy to those who are opposing jointly, while they are opposing on their own behalf. Included in the combined opposition are the boroughs of Blackburn, Accrington, Leigh, Rochdale, Wigan, Burnley, Eccles, and Nelson, besides other boroughs and several urban districts.

Portsmouth.—In conjunction with the new generating station a considerable number of electrically-driven machine tools are to be installed at the Navy Yard.

South Africa.—Durban.—A two days' electrical cooking and heating exhibition, under the auspices of the Durban Corporation, was opened on February 2nd in conjunction with the Horticultural Show. There were five local firms exhibiting: Messrs. Hubert Davies and Spain, Greenwood & Kilburn, F. H. Hadfield and Co., Jenkins & Co., and the India-Rubber, Gutta-Percha and Telegraph Works Co. Messrs. Hadfield & Co. are showing some of the recent "Olympia" exhibits, and other firms up-to-date appliances, by which it is hoped to popularise the demand for electricity for domestic purposes.

Stoke-on-Trent.—The T.C. has reduced the price of energy for power and heating to 1½d. per unit up to 7,500 units per annum; 1¼d. from 7,501 to 15,000; and 1d. for all beyond. The charge of 10s. per kw. per quarter will be discontinued.

The T.C. has decided to apply for a loan of £5,748 for additional plant for the electric light extensions, to meet next winter's demand.

Stratton and Bude.—The U.D.C. has come to the following agreement with the E.L. Co. for the establishment of an electricity supply:—The prices for energy are to be 4d. per unit for lighting, and 3d. for power to the Council, and 6d. and 3d. to ordinary consumers, with a discount of 5 per cent., when the dividends exceed 5 per cent., and a further discount of 5 per cent. for every 1 per cent. above 5 per cent. dividend. Overhead wires are to be allowed in the outside parts of Bude and at Stratton; no meter charge is to be made for public lighting; and the Council is to have the option of purchasing the undertaking after 21 years.

Tasmania.—Messrs. Noyes Bros. have secured a contract from the Mount Bischoff Tin Mining Co., Waratah, for the supply of an electric power plant for milling, hauling, traction and lighting purposes. The plant is to consist of two Escher-Wyss turbines direct-connected to two Westinghouse three-phase generators, supplying energy at 2,200 volts, 50 cycles. Transformers aggregating over 500 kw. and motors totalling 400 h.p. are to be installed. A surface tramway will be operated by a 13-ton Westinghouse-Baldwin locomotive at a line voltage of 550, while for mine haulage two small locomotives will be used, taking energy at a pressure of 110 volts.—*Australian Mining Standard.*

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space has been found for a large number of technical terms in small

is a good field in his district for the sale of material for electric

Torquay.—A L.G.B. inquiry was held on the 20th ult. into the application of the T.C. for sanction to borrow £2,950 and £2,050 for mains extensions and the provision of additional plant respectively.

Trowbridge.—Providing the sum of £350 is deposited forthwith by Messrs. Seymour, Williams & Co., the U.D.C. has decided to consent to the time for carrying out the E.L. order being extended for six months.

U.S.A.—New York City.—In regard to the question of providing a municipal E.L. plant, the Mayor has announced that he will not push the scheme, in view of the Edison Co. having reduced the price for arc lamps from $126 to $80.

Wellingborough.—As the County of Northampton E.L. and Power Co. has agreed to insert a clause under which it will have to supply any part of the district upon demand, the R.D.C. has decided not to oppose the company's application for a prov. order for electric lighting.

TRAMWAY and RAILWAY NOTES.

Barrhead.—The Paisley District Tramways Co. has intimated its intention to proceed at once with the extension of its system from Potterhill to the burgh.

Brighouse.—The T.C. has decided to accept the terms of the West Yorkshire Tamways Co., and to support the company's Bill for the construction of tramways connecting Halifax and Huddersfield *viâ* Elland, Rastrick and Brighouse.

Cape Town.—The following additional regulation under Sec. 2 of the Electric Lighting and Power Act of 1895 (Cape Colony) has been officially approved and gazetted:—"Every local authority or person now operating, or who shall hereafter operate, any electric tramway or electric railway undertaking for public purposes shall cause each electric car or other electrically-propelled vehicle running on the rails to be fitted at the forward end with a suitable fender of a type approved by the Government, which will act efficiently as a life protector. A vertical board or other arrangement capable merely of thrusting obstacles aside will not be considered efficient." This regulation will come into force on August 1st, 1906.

Colchester.—Recently Col. von Donop officially inspected an extension of the Colchester tramways from Magdalen Street, along Military Road to the Recreation Ground. The extension was constructed under the direction of the borough surveyor (Mr. H. Goodyear), and the electrical equipment was carried out by Mr. A. R. Sillar, borough electrical engineer. The inspector examined a switch operator patented by the general manager, Mr. R. C. Bullough. Its cost is about £40 as compared with £80, the cost of somewhat similar appliances worked by electricity. Mr. Bullough's switch is operated by the driver, and dispenses with point boys. By depressing a lever the driver causes a shoe with three teeth to engage a ratchet wheel, which causes an eccentric to make a semi-revolution, thereby moving the switch rail by means of a crank and connecting rod. Upon the Military Road section of the extension Mr. Bullough has also introduced his patent adjustable rail joint supports. These appliances have been in use for over 18 months in Manchester and Denton, and for six months in Liverpool, and they are now being laid down in Liverpool and elsewhere. Col. von Donop stated that his certificate would be forwarded in due course.

Continental Notes.—Germany.—The Continentale Gesellschaft für Elektrische Unternehmungen, of Nüremberg, has studied in a most complete manner the question of constructing a suspended mono-rail railway similar to that of Barmen-Elberfeld, for the town of Berlin. The line would pass by Gesundbrunnen, Rosenthals Thor, Alexander Platz, Moritz Platz, Herman Platz, and Rixdorf. The time occupied in one trip would be 22·25 minutes, with stops, on an average, every 4·4 minutes. The average speed would be higher than on the overhead or underground railways of Berlin, it not being necessary to slow up when taking the curves. The cars are 15 metres long, and can contain 85 persons. Arrangements are made for the conveyance of 40 to 50 million passengers per year.

Work is about to be commenced by the Phœnix Hütte Gesellschaft on the construction of an underground electric tramway between its ironworks at Laar and Ruhrort and its Westend Colliery at Meiderich for the transport of coal and slag.

An electric tramway is to be constructed between Rochlitz and Grunthal.

Belgium.—The Government has presented a proposal relating to the construction of an electric railway direct from Ostend to Aix-la-Chapelle. The curves will be at least 200 metres in radius, and the slopes will not exceed 1 in 1,000. The line will necessitate the construction of a tunnel 4,200 metres long, under the forest of Aix-la-Chapelle, a bridge nearly 2 km. long, at least 200 other bridges, and 260 viaducts.

Italy.—The *Gazzetta Ufficiale* (Rome) of February 13th contains Decrees authorising the Municipality of Milan to construct and work two electric tramway lines in Milan, and the Municipality of Mestre to construct and work an electric tramway in Mestre.—*Board of Trade Journal.*

The authorities of the province of Chieti have granted a concession for putting down a plant to utilise the water-power of the River Sangro in the generation of the energy required for the operation of an electric tramway between Frentana and Sangritina.

The "Bolletino delle Finanze" (Rome), of recent date, contains detailed information as to an important project which is to be carried out immediately by the Società Varesina per Imprese Elettriche, constituted with a capital of over 5,000,000 lire, in conjunction with important banking institutions in Milan. The project will serve to show the great development which is being made in the tramway and railway systems of this district. A new railway is to be constructed to establish communication between the station of Varese and the Luino line. Moreover, the stock on the latter electric line is to be increased and improved, so that instead of only five trains daily, there are to be eleven, and seven extra on holidays. Stations are to be constructed at Ganna and Grontola, picturesque districts much admired by tourists. The service on the Varese-Prima-Cappella line is to be greatly improved by a large increase of stock, and the establishment of a junction in the Piazza del Podesta. In the spring a 15-minute service will be inaugurated as against a 30-minute service. The tramway of Masnago will be joined to that of Prima-Cappella by a junction in Piazza Porcari; moreover, a junction is to be established near the new aerial railway of the Kursaal, and the stock is to be augmented. The new lines for which the projects have already been approved are the following:—Varese-Lago, Varese-Brinzio, Varese-Azzate, Varese-Bizzozero. Furthermore, it is proposed to construct a line round the town touching all the most interesting places in the district.

Switzerland.—The completion of a Bernina Railway, running from St. Moritz in the Engadine *via* Pontresina and the Bernina Hospice to Tirnano, Valtellina, has, according to *Helios*, been proposed for 1907. The line will be 60 km. long, and will cost £480,000. Electrical energy will be supplied from the electricity works in Brusio; three-phase current will be employed at 50 periods and will be transmitted by a high-tension system to four converter sub-stations.

Glasgow.—Correspondence which has taken place between the town clerk and Mayor Dunne, of Chicago, in regard to the publication of the report of Mr. James Dalrymple, the tramways manager, on the municipalisation of the Chicago trams, has been issued to the Press. The town clerk, on behalf of the Tramways Committee, wrote to Mayor Dunne that when the Corporation granted permission to Mr. Dalrymple to visit Chicago and report upon the tramways, it was understood that the request came from Mr. Dunne not as an individual, but as the Mayor of the city. The Tramways Committee was now led to understand that Mr. Dunne claimed that his request was made as a private individual. If this had been made clear to the Corporation there is little likelihood that the application would have been granted. The Corporation expected that any report made by their general manager would have been accessible not only to the Council of Chicago, but also to the members of Glasgow Corporation. The general manager, however, had refrained from submitting his report until Mr. Dunne had had ample opportunity of first submitting it to the Council of Chicago. The Committee did not see how it could longer delay complying with the application addressed to it by the Council of Chicago, and decided to issue the report to the Chicago Council and to the members of the Glasgow T.C.

Heywood.—The conversion of the Heywood tramways from steam to electricity was completed on February 24th, the work having taken six months. The principal contract was carried out by Messrs. Blackwell & Co., of London, and the total cost will exceed £50,000. Over £20,000 had to be paid for buying out the old steam tramway company. The completion of the Heywood tramway system makes it possible for a journey to be made by electric car from Halifax to Liverpool. The B. of T. inspection was fixed for yesterday.

India.—Bombay.—Work was to be commenced on the electric tramways at the beginning of last month; a local dispatch states that the overhead system is not to be used.

Kew Observatory.—Arrangements are in progress for the removal of the Kew Magnetic Observatory to Eskdalemuir, Dumfries-shire, where electric tramways are unknown. Considerable magnetic disturbance has been caused by the tramway from Brentford to Twickenham.

Kingston.—Yesterday the new service of the London United Tramways was opened, through Kingston, Long Ditton, Raynes Park, &c., one branch crossing Kingston Bridge.

Leicester.—The first year's working of the electric tramways has resulted in a total revenue of £109,541, and working expenses £63,828, leaving a balance, including bank interest, of £46,566. After payment of interest and sinking fund, the net balance is £14,063, which is carried to reserve. The total capital expended was £673,179. During the year nearly 26 million passengers were carried, the average traffic revenue per car-mile being 7·761d. and the working costs 4·583d. The journeys per head of population amounted to 113.

Lancashire.—An electric tramcar in descending Bardsley Brow, a steep hill midway between Oldham and Ashton-under-Lyne, last week, ran with terrible force into a heavy traction engine belonging to Messrs. Denton Brothers, of Hyde. The car driver, who stuck to his post bravely, was thrown forward on the roadway, and alighting on his head was severely injured. The road engine, which was drawing a large boiler, was knocked backwards about 20 ft., its driver having a marvellous escape. The car was very badly damaged. Two passengers, realising what was about to happen, saved themselves by jumping off. The guard was badly shaken. Traffic was disorganised for the greater part of the day.

An accident, similar in character, occurred on the road between Bury and Bolton the same day. An electric car belonging to the Bury Corporation collided with a coal cart, which, by the force of the concussion, was driven against a two-horse lorry. The car-driver and the lorry driver were seriously hurt, but no passengers received injury. At the time of the accident the car was descending a steep incline.

Liverpool.—At the first meeting of the newly amalgamated Tramways and Electric Power and Lighting Committees of the Liverpool Corporation, on Friday last, Sir Charles Petrie was elected chairman of the Committee, and Alderman F. Smith deputy chairman. The proceedings of the Traffic Sub-Committee showed that the sub-committee had considered a proposal to run motor-'buses on the Edge Lane route, but had decided against it, the traffic manager having reported that such a service would not be remunerative owing to the heavy wear and brake friction on the tires on account of the gradients, and by reason of the small carrying capacity of the 'buses. Motor-'buses had been run during the motor show, and had earned about £67. The traffic manager understood that £9 per day was charged for each of the larger 'buses, and £40 per week for the smaller 'bus. This worked out to more than three times the amount of the earnings.

Liverpool-Southport Railway.—A fire occurred on an electric train on this line on Friday afternoon. When the train entered Exchange Station, Liverpool, the front portion was burning. The extinguishing apparatus was promptly used, and the flames were speedily subdued. The damage done was not serious, but the passengers were considerably alarmed, and traffic was slightly delayed.

London.—L.C.C.—On Saturday last the Kingsway subway car service was opened to traffic, cars running from the station in Aldwych to the Angel, at Islington.

The B. of T. has notified the L.C.C. that it is prepared to approve the increase in speed proposed by the Council to 16 miles an hour from Canal Bridge to New Cross Gate; 12 miles an hour from New Cross Gate to Deptford Bridge; 12 miles an hour in Pomeroy Street, Kender Street, and Queen's Road; and 16 miles an hour from Kender Street to New Cross Gate (Queen's Road route).

Metropolitan District Railway.—On Friday last a train left the rails near Mansion House Station at 3 p.m., and traffic was stopped till 6.30. A further breakdown took place at the Mansion House on Saturday, due to a train jumping the metals, about 11 p.m., and delayed traffic for some considerable time.

The report of Major J. W. Pringle, B. of T. inspector, with reference to the collision between electric trains on January 4th, at North Ealing Station, shows that the collision was entirely due to the driver of a special train having passed the automatic signal at North Ealing when it was in the danger position.

Central London Railway.—On Sunday last a complete failure of the electricity supply took place at 12.35 p.m., owing to a short circuit. The stand-by battery service was immediately connected with the station lighting, but for some time darkness prevailed in the tunnels and in some of the stations. Panic was averted by the prompt action of the conductors. At Chancery Lane a lift full of passengers was suspended, halfway up, for 20 minutes.

North London Railway.—In moving the adoption of the report of this company, Lord Rathmore attributed the decrease in the number of passengers during the last five or six years to the severe competition set up by the electric railways and tramways, and more recently to the motor-'buses. There had been a decrease during the past six months of 614,637 passengers. Electrification of the line was exceedingly difficult, owing to the company's trains running over other systems, while the controversy between the advocates of the third-rail and of the overhead system was still unsettled, and electric power was not yet available. The cost of conversion would also be very great.

Mansfield.—An inquiry has been held by the Light Railway Commissioners into the application of the Mansfield and District Light Railways Co. for powers to extend their lines to Mansfield Woodhouse, Stanton Hill, and beyond Hucknall Huthwaite.

Luton.—The Tramways Committee has recommended the T.C. to apply to the B. of T. for a loan of £57,000 for laying, equipping and working electric tramways.

Newcastle-on-Tyne.—Mr. E. Hutton, the general manager of the Corporation tramways, has issued to members of the Committee his estimates for the coming year from March 31st, 1906, to 1907. The income is:—From traffic, £197,600; public lighting, £3,750; sundries, £650. The expenditure is:—Traffic expenses, £60,000; general expenses, £16,900; general repairs and maintenance, £19,900; power, £9,250; maintenance and repairs at power station, £3,900. This gives a total income of £202,000, and a total expenditure of £109,950. The latter item is further increased by £1,000, the cost of public lighting. This leaves an estimated gross surplus of £91,050, out of which provision must be made for interest and sinking fund charges, &c., totalling £71,850, leaving an estimated net surplus of £19,200. Owing to the extensions that are being made, some of the interest will be on unproductive capital. For the year ending March 31st, 1906, the net surplus is estimated at £11,330, but this will be reduced on account of maintenance of permanent way.

Oxford.—The T.C. has passed a resolution appointing a committee to consider the tramway question, with especial reference to the suitability of motor-'buses.

Rochester.—Messrs. Dick, Kerr & Co., contractors, on Friday last commenced operations for extending the Rochester Corporation electric tramways from Star Hill up Maidstone Road to Delce Grange. This work, including the erection of the overhead equipment, will, it is estimated, be completed by May.

Major J. E. Stewart, R.E., one of the L.G.B. inspectors, sat at the Guildhall, Rochester, on Thursday last week, at an inquiry consequent upon the application of the City Council to borrow a sum of £35,000 for the purchase of land and property under the Corporation Tramways Act, 1903. This sum is an addition to the £69,888 which the statute authorised.

United States.—Buffalo, N.Y.—The Subway Railroad Co. has been incorporated with a capital of £200,000 to construct an underground electric railway 8 miles long.

Chicago, Ill.—Mr. W. J. Dunne, mayor of Chicago, who withheld from publication the report of Mr. James Dalrymple, of Glasgow, on the possibilities of municipally-operated electric street cars in Chicago, has recently explained that he invited Mr. Dalrymple to visit the United States in his personal capacity, and paid the expenses out of his own pocket. The continued withholding of the report has been severely criticised.

New York Central Railroad.—On February 9th the electric locomotive No. 6,000 was tested during a snowstorm, and made between 60 and 70 miles an hour on the General Electric Co.'s experimental track at Schenectady, N.Y. The engine successfully negotiated several snow drifts. Electric traction on the Harlem suburban division is announced for July 1st. The General Railway Signal Co., of Rochester, N.Y., has received an order from the New York Central Railroad for interlocking and block signals to the amount of £400,000. These are for the zone within 25 miles of New York City.

New York City.—The quarterly report of the Interborough Rapid Transit Co., dated December 31st, shows an increase of £141,749 in gross earnings, and of £24,742 in net income over 1904. On the subway division the gross earnings were £377,463, equivalent to a passenger total of more than 420,000 daily. The subway platforms are to be lengthened to accommodate eight-car trains. Mr. W. B. Parsons, who engineered the present subway, states that the cost of the construction of future subways will be 50 per cent. greater than that of the old. A west-side subway from the Battery to the Bronx, he says, would cost £17,000,000. The existing subway cost £7,250,000, and its electrical equipment £5,000,000 more. The city has a borrowing capacity of only £15,000,000, should it decide to build its own new subways. An appropriation of £150,000 has been made to improve the street car and elevated facilities on the city bridges. Plans have been published for a moving platform over the Williamsburg Bridge to carry 60,000 passengers an hour. Mr. F. B. Behr, an English electrical engineer, is projecting a mono-rail electric road to connect the city with Coney Island. The Pennsylvania Railroad is to build a large power station for its electric traffic opposite its New York terminus; the engineers are Messrs. Westinghouse, Church, Kerr & Co., and the estimated cost of the building is £60,000.

Interurban electric railways in the United States added largely to their mileage and equipment during the year 1905. Statistics collected by the *Railway and Engineering Review* give a total of 941 miles of interurban road constructed and put into operation during the past year. These figures exclude, as far as possible, all mileage constructed as city street railway. New generating units to total 38,910 KW. are reported for interurban uses alone. Large increases in the scheduled service are commonly reported, for passenger service 10 to 25 and 30 per cent. being the common figure, and for freight service 20 to 60 per cent.

Wednesbury.—The T.C. has at last arrived at an agreement with the South Staffordshire Tramways (Lessee) Co. for leasing the tramways, which are to be electrified, for 30 years. The company will pay £996 per annum as rent and an additional £150 a year for the first 15 years and £100 per annum for the remaining period.

West Ham.—The undertaking given by the Corporation to the B. of T. last month that no further money should be borrowed for tramway purposes under Sec. 73 of the Act of 1900 beyond the £154,240 already raised has been varied, with the consent of the Board, by increasing the amount to £184,740. It was found that the additional sum would be required to complete the original scheme.

200 other bridges, and 260 viaducts.

7·761d. and the working costs 4·583d. The journeys per head of population amounted to 113.

TELEGRAPH and TELEPHONE NOTES.

Cuba.—The Government has sanctioned the expenditure of $20,000 on constructing and repairing telegraph lines and wireless telegraph installations.—*Board of Trade Journal.*

Mauritius-Réunion.—The text of the convention between the United Kingdom and France respecting telegraphic communication between Mauritius and Réunion, which was ratified on January 10th, was issued on Tuesday last. It provides that the French Government will establish, at its own cost, a submarine telegraph cable between the two islands, the section within the territorial waters of Mauritius being ceded to the British Colonial Government on condition that the French Government shall have the right to take it up at the expiration of the convention. The cable must be open for traffic within two years of the ratification of the convention, which is to last for 25 years. The rates proper to the cable from Réunion to Mauritius shall belong entirely to the French Government, the terminal or transit rate in respect of the working of the cable in the Island of Mauritius being limited to a sum not exceeding 20 centimes per word.

New Cables.—The B. of T. has received an application from the Eastern Telegraph Co., Ltd., for a licence to lay down and maintain on the foreshore and bed of Porthcurnow Bay, Cornwall, two cables to Fayal, Azores. Objections have to be lodged within 28 days from February 23rd.

Postal Telegraphs.—Last Friday the Postmaster-General received a deputation from the Parliamentary Committee of the Trade Union Congress on the subject of wages paid by contractors, and on the select committee of inquiry promised by Mr. Buxton.

Siam.—The Siamese Government announces the opening of a telegraph station at Puket, situated on the island of the same name, north of Penang.

Swansea.—Major Cardew (appointed by the High Court), Mr. Gill (representing the National Telephone Co.), and Mr. Bennett (consulting engineer to the Swansea Corporation telephones) recently inspected the Swansea telephone systems, in view of the appeal by the National Co. against the recent judgment giving intercommunication to the Corporation.

Peru.—The Government has sanctioned the expenditure of £1,091 during each of the years 1906-7, on the construction of a telegraph line to connect Puquio and Coracora.—*Board of Trade Journal.*

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Cayenne-Pinheiro	Aug. 18, 1902	
Port Arthur-Chifu (Closed)	Mar. 7, 1904	
Jamaica-Colon	Jan. 5, 1905	
Cadiz-Tenerif	July 20, 1905	
Tarifa-Tangier	Jan. 18, 1904	
Puerto Plata-Martinique	Oct. 30, 1905	
Panama-Buenaventura	Feb. 1, 1906	
Buenaventura-St. Elena	Feb. 1, 1906	
Vladivostock-Nagasaki	Feb. 7, 1906	Feb. 21.
St. Vincent-Grenada	Feb. 16, 1906	
St. Vincent-St. Lucia	Feb. 16, 1906	
Tangier-Cadiz	Feb. 18, 1906	
St. Jacques-Haiphong	Feb. 14, 1906	Feb. 21.
Panama and Colon *via* Galveston	Feb. 21, 1906	Feb. 26.
Grenada-Trinidad	Feb. 22, 1906	
S. Juan-St. Thomas	Feb. 24, 1906	
Ponce-St. Croix	Feb. 24, 1906	
Landlines.		
Puerto-Barrios	Aug. 28, 1902	
Communication with Brazil *via* Galveston	July 18, 1905	
Bachkale-Deliman	Feb. 12, 1906	
Bagdat-Bassorah	Feb. 20, 1906	Feb. 21.

Wireless Telegraphy.—The *Times* says that the firm of Messrs. Bland, of Gibraltar, who have large commercial relations with Morocco, have made a proposal to the Sultan to undertake the erection of a Marconi receiving station at Fez, which would be in direct communication with the Poldhu station in Cornwall.

The Postmaster-General, in the House of Commons, brought in a Bill to continue the Wireless Telegraphy Act of 1904, and it was read a first time on the 26th ult.

The *Standard* states that perhaps the most interesting feature of the naval manœuvres is the wireless telegraphy, for it is by this means that in time of war the Commander-in-Chief would keep in touch with his many fleets, and sweep the seas of the world. Each battle and cruiser squadron, states the correspondent at Lagos, moved direct and independently to its appointed place in a large imaginary circle, to begin the most important "Marconi" trials that have yet been carried out in the Navy. What the exact nature of these tests is, and with what result they have been executed, are confidential matters which will not be made known to the public.

The B. of T. has received, through the Colonial Office, a copy of The Wireless Telegraphy Ordinance, 1905," which was enacted by the Administrator of British New Guinea on November 2nd last. The ordinance in question grants to the Administrator the sole privilege of transmitting and receiving messages by wireless telegraphy in British New Guinea, and of granting licences for the establishment of stations and appliances for the purpose of wireless telegraphy on the payment of such fees as may be prescribed.—*Board of Trade Journal.*

CONTRACTS OPEN and CLOSED.

OPEN.

Barnes.—March 12th. Water-tube boiler, condenser, pump and pipe-work, for the U.D.C. See "Official Notices" February 23rd.

Belfast.—March 19th. One 400-KW. steam dynamo for the Corporation. See "Official Notices" to-day.

Belgium.—The Société du Gaz, of Namur, is inviting tenders for the establishment and equipment of a central electric lighting station in the town. Particulars may be obtained for 3 fr. from, and tenders are to be sent to, La Société du Gaz de Namur, 15, Avenue Prince Albert, Namur, Belgium.

Bilston.—March 12th. Electric lighting of the new schools now being erected at Stonefield. See "Official Notices" February 9th.

Briton Ferry.—March 26th. Sub-station switchboard, feeder and distributor cables, feeder pillars, joint boxes, arc lamps and standards, for the U.D.C. See "Official Notices" to-day.

Dublin.—March 9th. Arc lamp carbons for the Corporation electricity department. See "Official Notices" to-day.

East Indian Railway.—The company is inviting tenders for electrical equipment for transformer house. See "Official Notices" to-day.

Edinburgh.—March 12th. Carbons, pavement boxes, meters, service fuse boxes and bitumen, for the Corporation. See "Official Notices" February 23rd.

Erith.—March 12th. Stores for the electricity works. See "Official Notices" February 23rd.

Fulham.—March 14th. General and electrical stores for the B.C. See "Official Notices" to-day.

Gillingham.—March 26th. Coal and meters for the electricity department. See "Official Notices" to-day.

Great Central Railway.—March 6th. Electric light materials, india-rubber telegraph materials and many other stores and materials. Particulars and form of tender from Mr. A. W. Longden, Storekeeper, Cornwall Street, Openshaw.

Greenock.—March 15th. Two D.C. steam dynamos of 750-KW. each; one 500-KW. D.C. motor-generator for the Corporation. See "Official Notices" to-day.

Huddersfield.—March 9th. Vertical engine and piping; 750-KW. traction generator; switchboard and cable extensions, for the Tramways Committee. See "Official Notices" February 23rd.

Johannesburg.—March 31st. 350 street lamp fittings, 50 stays for ditto, and 600 ft. gas barrel for the T.C. See "Official Notices" February 16th.

Leeds.—April 9th. Steam turbine, two-phase alternator and exciter (3,000 KW.), condensing plant and piping, for the electric lighting department. See "Official Notices" February 23rd.

L.C.C.—March 20th. Seven electrically-operated car traversers. See "Official Notices" to-day.

L.C.C.—March 26th. Lighting and power installation for the Long Grove Asylum, Epsom, now erecting. See "Official Notices" February 23rd.

Manchester.—March 3rd. Stores for the Corporation tramways. See "Official Notices" February 23rd.

Pontypridd.—March 3rd. Reservoir, condensing plant, cooling tower and tank, and artesian well for the U.D.C. See "Official Notices" February 9th.

1906 to 1907. The income is:—From traffic, £197,600; public

scheme.

Portsmouth.—March 5th. Water-tube boiler, economiser, pumps, condenser, cooling tower, and one triple-expansion 1,000-kw. low-speed vertical generating set; switchboard alterations and additions, for the Corporation. See "Official Notices" February 16th.

Stockport.—March 5th. Five double-deck top-covered cars, single truck type, complete with electrical equipment for overhead traction. Mr. John Atkinson, Borough Surveyor, Stockport.

Sunderland.—March 2nd. Feed pump, cooling tower, surface condenser, coal bunkers, &c., for the Electricity Department. See "Official Notices" January 26th.

Swindon.—March 12th. Various materials for the electricity and tramways department. See "Official Notices" February 23rd.

Sydney (N.S.W.).—May 7th. Boilers, stokers, pipework, turbo-alternator, sub-station machinery, switchboards, &c., for the Council. See "Official Notices" February 9th.

Warrington.—March 13th. High and low tension cables for the Corporation. See "Official Notices" to-day.

West Ham.—March 2nd. Lamps, cable, motors, transformers, meters and cut-out boxes, for the Electricity Department. See "Official Notices" February 16th.

CLOSED.

Birmingham.—The British Westinghouse Electric and Manufacturing Co., Ltd., have received the order to equip with magnetic brakes 200 cars now being delivered to the Birmingham Corporation, by Messrs. Dick, Kerr & Co., Ltd.

Bristol.—The Docks Committee has accepted the tender of the British Insulator Co. for the supply of arc lamps for Avonmouth Dock.

Croydon.—The T.C. received the following tenders for the supply of a 1,000-kw. direct-current generator and traction feeder panels:—

Generator.		Feeder Panels.	
Dick, Kerr & Co. (accepted)	£6,975	Siemens Bros. & Co. (accepted)	£198
Siemens Bros. & Co.	7,133	British Westinghouse Co. ..	215
Brit. Thomson-Houston Co.	7,255	British Thomson-Houston Co.	235
Electric Construction Co. ..	7,363	,, ,,	220
British Westinghouse Co. ..	7,584	Cowans, Ltd.	229
		Ernest F. Moy	327
		Dick, Kerr & Co.	330

Glasgow.—The Tramways Committee has accepted the following tenders:—

Channel steel, Messrs. P. & W. McLellan, Ltd.
Special track work, the Lorain Steel Co.
Birch, Messrs. J. G. McPheen & Co.
Dog-wood for section insulators, Mr. John Forbes.

Grimsby.—The Committee last week recommended the acceptance of the following contracts:—

500-kw. dynamo and engine		Brush Elecl. Eng. Co.	£2,410
Water-tube boiler and automatic stoker ..		Stirling Boiler Co. ..	1,428
Extensions of switchboard		Johnson & Phillips ..	205
Pipe-work		John Wilson & Co. ..	741
Cables		Johnson & Phillips ..	1,265
Coal Conveyor		Chain Belt Eng. Co.	243
Condensing plant		Brush Elecl. Eng. Co.	907

London.—Islington.—The B.C. has accepted the following tenders for the annual supply of stores, &c., to the Electricity Department:—Messrs. J. Knowles & Co.; Robertson Electric Lamps, Ltd.; Berry, Skinner & Co.; Alexander Duckham and Co.; Middleton Bros.; Pryke & Palmer; H. Edmonds & Co.

Stepney.—The B.C. has received the following tenders for installing the electric light in St. George-in-the-East baths and wash-houses:—

G. Weston & Sons (accepted) ..	£177	Tamplin & Makowski	£239
A. Sweet	195	C. Ross	240
E. D. Pearcey	202	D. Assersohn	257
W. J. Fryer & Co.	205	Smeeton & Page	267
Electrical Engineering & Maintenance Co.	210	Jackson Bros.	275
J. Richmond & Co.	210	F. A. Glover	282
Ward Bros.	217	J. Defries & Sons	302
J. Potter & Sons	225	G. & H. Turner	307
Holmes & Cooper	226	Laurences, Ltd.	345
W. Palmer	237	Fergusson & Sons (informal) ..	420
		Donnison, Sillem & Co.	465

Battersea.—The B.C. has accepted the tender of Messrs. Mather and Platt, Ltd., for plant for the generating station at the following prices:—Steam dynamo, of a capacity of 850 kw., with Belliss engines, £6,446; Korting condenser, £140; spare armature, £800; drains, £6; total, £7,392.

Marylebone.—The B.C. has received the following tenders:—Centrifugal pump for generating station:—8

Gwynnes, Ltd.	£60 0
Ernest Scott & Mountain, Ltd. (accepted)	62 10
Drysdale & Co.	81 0

Wiring offices for electricity department:—

Pinching & Walton	£191 0	F. Brown	£112 10
Barlow Bros.	117 0	R. S. Robertson (accepted)	88 0

On the results of the analysis of samples the tender of Craig, Sharp & Co., for the annual supply at £22 10s. per ton of box compound to the electricity department has been accepted; also the tender at £2 5s. per ton of the British Electric Trades Co. for the annual supply of pitch.

L.C.C.—The following tenders have been received by the L.C.C. for the reconstruction of certain of the northern tramways as mentioned:—

1.—Shoreditch to Stamford Hill.

J. G. White & Co.	(recommended)	£141,399	6	9
Dick, Kerr & Co.		143,105	6	0
Wm. Griffiths & Co.		145,501	9	2
Robert W. Blackwell & Co.		147,887	5	5
John Mowlem & Co.		147,717	0	0
Estimate (comparable with tenders)		£135,980	9s.	9d.

2.—Bloomsbury to Poplar.

Dick, Kerr & Co.	(recommended)	£238,045	12	8
J. G. White & Co.		239,995	5	6
Wm. Griffiths & Co.		242,425	12	8
John Mowlem & Co.		243,190	10	0
Estimate (comparable with tenders)		£226,831	18s.	8d.

It is proposed in the Shoreditch-Stamford Hill contract to make provision for a length of two miles of single line to be reconstructed for the side-slot conduit system.

The Asylums Committee of the L.C.C. has accepted the tender of Edmundson's Electricity Corporation for extending and making additions to the generating plant at the central station at Horton Asylum.

Middlesex.—The County Council has accepted the tender of Messrs. Davies, Ball & Co., at £4,669 16s., for the reconstruction of the bridge over the Grand Junction Canal at Old Oak Lane, in connection with Light Railway No. 8. Messrs. Radford & Greaves, whose tender had previously been accepted at £4,326, declined to enter into the contract.

Oban.—The T.C. has accepted the tenders of Messrs. Venner & Co. for the supply of meters for 12 months to December 31st next, viz., 1½ amperes, £1 12s. 6d. each; 3 amperes, £1 18s. 6d.; 5 amperes, £2 2s. 6d. each; 10 amperes, £2 7s. 6d. each; 25 amperes, £2 12s. 6d. each; 50 amperes, £3 each; 100 amperes, £3 5s. each.

Southend-on-Sea.—The Council has accepted the tender of Messrs. F. Pratt & Co., Ltd., for a lathe for turning steel-tired wheels, at £145 10s.

The Corporation has accepted the tender of Messrs. Crompton and Co. for a Crompton-Belliss steam dynamo, at £2,857.

Walthamstow.—The U.D.C. has accepted the following tenders for the annual supply of stores to the Electricity Department:—

Lamps, Electrical Co., Ltd.: Nernst Lamps, ditto.
Irene shades, Beam Co.
Opal and iron enamelled shades, Sunbeam Co.
Cut-outs, Edison & Swan United Electric Light Co., Ltd.
House service and fuse boxes, Reason Manufacturing Co., Ltd.
Rheostats, Electrical Co., Ltd.
Holders, ceiling roses, wall plugs, adapters, key switch holders, counterweights, fuses and bridges, Edison & Swan United Electric Light Co., Ltd.
Distributing boards, Mr. R. F. Coulston; wood blocks, ditto.
Para-rubber strip and black adhesive tape, Connolly Bros., Ltd.
Splicing gum, British Thomson-Houston Co., Ltd.
Blackley tape, Connolly Bros., Ltd.
Casing and capping, Edison & Swan United Electric Light Co., Ltd.
India-rubber solution, Mr. R. F. Coulston.
Orange shellac varnish, General Electric Co., Ltd.
White cotton waste and engine wipers, Mr. R. F. Coulston.
Sponge cloths, Croager Bros., Ltd.
Lubricant, Isaac Bentley & Co., Ltd.
Binding and fuse wire, Mr. R. F. Coulston.
Phosphor bronze and copper wire, General Electric Co., Ltd.
Tinned copper, tinned steel, and soft iron wire, Mr. R. F. Coulston.
Armoured and lead-covered cables, Henley's Telegraph Works Co., Ltd.
Vulcanised india-rubber cables, Connolly Bros., Ltd.
Enamelled steel conduit, General Electric Co., Ltd.
Carbons, London Lamp Works.
Enclosed arc lamp carbons, General Electric Co., Ltd.
Copper wire brushes, London Wire Co.
Steam and gas barrel, Good Bros.
Telephone sundries, General Electric Co., Ltd.
Langham shades, Beam Co.
Switches, Edison & Swan United Electric Light Co., Ltd.
Ironclad switches, Beam Co.
Ironclad cut-outs, Reason Manufacturing Co., Ltd.
Fittings, General Electric Co., Ltd.
Linen tape, Applebee Bros.
Flexible and telephone wire, Connolly Bros., Ltd.

West Ham.—The Corporation on Tuesday accepted the tender, at £7,429, of Messrs. Willans & Co. (with Dick, Kerr generator) for the supply of a 1,500-kw. turbo-generator. There were 15 tenders.

Educational Note.—University of Leeds.—The second report of this University, for 1904-5, shows that while the income for the year exceeded the expenditure, a sum of £30,000 still remains to be collected to complete the capital endowment of the Yorkshire College. The chief need of the University is more space, the science and technology departments being especially deficient in this respect. There were 33 students in electrical engineering during the session. Mr. G. D. A. Parr is the lecturer in this subject, assisted by Mr. A. W. Ashton.

the Administrator of British New Guinea on November 2nd last.

"Official Notices" February 9th.

FORTHCOMING EVENTS.

To-day's Events (Friday, March 2nd).—Junior Institution of Engineers. At 7 p.m. Mr. A. P. Trotter on "Acceleration and Accelerometers.' At 8 p.m.—Mr. L. F. de Peyrecave on "Gas Engine Indicators."

Saturday, March 3rd.—At 3 p.m. I.E.E.-(students) visit to the P.O. Telephone Exchange, Addle Hill, E.C.

At 3 p.m. Royal Institution. Prof. J. J. Thomson on "The Corpuscular Theory of Matter."

At 8 p.m. Electrical Engineers, R.E.V. Bohemian Concert at Caxton Hall, Westminster.

At 7.30 p.m. Glasgow Technical College Scientific Society. Mr. A. Stewart on "Portable Electrical Tools and their Application to Industrial Purposes."

At 8 p.m. Eltradion Athletic Club. Bohemian Concert at the Mail Coach, Farringdon Street, E.C.

Tuesday, March 6th.—At 8 p.m. I.C.E. Mr. J. J. Webster on "The Widnes and Runcorn Transporter-bridge."

Thursday, March 8th.—At 8 p.m. I.E.E. Mr. V. A. Fynn on "A New Single-Phase Commutator Motor."

Friday, March 9th.—At 7.30 p.m. I.E.E. (Manchester Students). At Royal Technical Institute, Salford. Messrs. E. Müller and J. Davies on "Modern Primary Batteries."

At 8 p.m. Physical Society. Dr. Harker on "Some Experiments on Earth-currents at Kew Observatory."

Saturday, March 10th.—At 10 a.m. I.E.E. (Students). Visit to Messrs. Elliott Bros.' Works, Lewisham.

At 3 p.m. Royal Institution. Prof. J. J. Thomson on "The Corpuscular Theory of Matter." (Lecture II.)

At 7 p.m. Junior Institution of Engineers. Reception at Westminster Palace Hotel.

At 7.30 p.m. Birmingham and District Electric Club. Colonnade Hotel. Mr. R. G. Mercer on "Electricity in Mines."

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued:—

Monday, March 5th.—"A" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.

Tuesday, March 6th.—"B" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.; medical examination recruits, 7 p.m.

Wednesday, March 7th.—"A" badge examination for "A" and "B" Companies.

Thursday, March 8th.—"C" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.

Friday, March 9th.—"D" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.

Saturday, March 10th.—Week-end instruction for "C" Company (country members).

J. H. S. Phillips, Captain E.E.

For O.C.E.E.R.E. (V.).

NOTES.

Institution and Lecture Notes.—Institution of Electrical Engineers, Manchester Students.—The second annual dinner in connection with the Students' Section was held in the Grand Hotel, Manchester, on Saturday evening last, when about 40 members and friends were present. Mr. S. L. Pearce presided, and was supported by Mr. T. L. Miller (vice-chairman), Mr. A. E. Jepson (vice-chairman of the Students' Section), and Mr. C. D. Taite.

After the chairman had proposed the toast of "The King," Mr. Taite proposed the "President of the Institution, coupled with the names of the chairman and vice-chairman of the Students' Section." Mr. Taite said he would like to see all the students present at the dinner to be held the following week, when they could hear the President (Mr. Gavey) themselves. The membership of the Institution had grown rapidly of late, greatly due, he thought, to the development of the Students' Sections; he was pleased to see one was to be started in Glasgow, and had heard rumours of one in Birmingham. The Students' Section offered many advantages to its members. It was a great help to be able to express one's views in public and take part in a discussion. There was no better place to start than in the Students' Section.

Mr. Pearce, in replying, said the Manchester Section was the strongest of the local sections connected with the parent Institution, and they ought to congratulate themselves on their strength and the quality of the papers read. They were endeavouring to bring about a close connection between the Senior and Students' Sections, and he was glad to hear that Students' Sections were to be started in other places. The advantages which a student of to-day had, compared with one of, say, 1900, were very great. Mr. A. E. Jepson also replied.

Mr. R. W. Willis proposed "Our Guests," and referred to a proposal to start a monthly journal in connection with the Students' Section. He thought that if the different sections were to join together and print the papers read and the discussions on them, it would be very instructive to the members. Mr. T. L. Miller replied.

Mr. J. G. Potts proposed "Our Entertainers," to which Mr. H. D. Symonds replied.

I.E.E. Manchester Students.—On January 26th Mr. F. Shaw read a paper on incandescent and arc lamps. He thought the most important defect of carbon for a filament was that it had a negative temperature coefficient at the working temperature. The result was that small changes in voltage produced much larger changes in current through the filament, and as such changes had to be kept small it was essential that the voltage must be kept constant within narrow limits. The ideal substance for an incandescent lamp filament would be a material easily formed into a filament of high specific resistance, having a large positive temperature coefficient and high fusing point, cheap to produce, and capable of withstanding the high temperature necessary to give high luminous efficiency for an unlimited period without crystallisation or disintegration of any kind. The author next dealt with arc lamps, and said that the size of carbons employed had a very important influence on the total light emitted by an arc. It would be found in practice that in most cases larger carbons were used than were justified from an efficiency standpoint.

Manchester Geological and Mining Society.—At the last meeting of this Society a paper on the use of electricity in mines was read by Mr. P. Barrett Coulston. Winding, he said, was the greatest obstacle that electrical engineers had to overcome, for there could be no doubt that, in mines of large capacity, the cost of an electrical winding gear was considerably higher than for a mechanical winding gear; and the opinion was general that it was almost impossible for any electrical system to supersede that now in general use. Mr. Coulston said he believed this to be a totally erroneous conclusion (from the electrical engineer's point of view), and to be largely due to the fact that electrical engineers had not yet thoroughly laid themselves out to cope with the question. There were several systems now under consideration—such as the Rateau and Georgi continuous winding, and the Berchnedorff. Mr. Mountain's figures showed that whilst there was an undoubted saving in the actual working costs, the interest on the first cost militated greatly against the electrical drive. The writer was of opinion that Mr. Mountain's costs were distinctly high, and, even using the same system, he felt satisfied that an electric plant could be installed at a considerably less first cost. But these comparisons were taken on a plant for one shaft only. Where there were several shafts, the electrical drive would at once begin to compare favourably, as regards first cost, with the mechanical system, owing to the possibility of having a central generating station and boilers instead of a number of isolated batteries. Moreover, when the fact was considered that the electric current might be supplied to the winding plant and also to machines underground, instead of erecting a separate plant, the discrepancy in the costs of the mechanical and electrical systems again became greatly reduced. If the electrical system were adopted for the whole of the operations on the surface and underground, the cost of the machinery, as shown by some recent calculations, would be but slightly higher than that required for the mechanical system, and the actual working costs were reduced from 10 to 30 per cent.

Mr. Coulston described different types of electrical coal cutters, and summarised the results obtained from actual experience as follows:—(1) An increased output per man employed; (2) coal could be economically worked that, previously, had been unworkable at a profit by hand labour; (3) more systematic working; (4) better round coal; (5) greater area exposed in the same time; and (6) premium per ton for risk of life is reduced by one-third. He further stated that no difficulty was experienced in training men who had been previously employed in charge of steam plant on the surface to take over electrical plant; and these men themselves admitted that their duties were considerably lightened with electrical plant.

In the course of discussion, Mr. John Gerrard, H.M. Inspector of Mines, said so many papers had been read on this subject, from a general point of view, that it was time specific figures should be given with regard to the work done and its cost. Mr. Pope said the information could, and would, be furnished by any of the electric power supply companies.

The President (manager of large collieries near Manchester) joined Mr. Gerrard in asking for figures.

Mr. Pilkington expressed the view that coal cutters, electrical or otherwise, were only serviceable in hard seams. Mr. Coulston replied that the latest appliances provided against changes in the quality of the coal.

Institution of Mechanical Engineers.—The annual report of the Institution shows that the membership now numbers 4,750. The total assets of the society amount to £74,774, the net capital, after deducting debentures, &c., being £41,688. Investigations are in progress relating to steam-jacketing, alloys and gas engines. The summer meeting will be held in Cardiff. At the annual general meeting on the 16th ult., Mr. E. P. Martin was re-elected president for the year.

Junior Institution of Engineers.—Through the courtesy of Mr. A. P. Trotter, the electrical adviser to the Board of Trade, who was, however, unfortunately prevented through indisposition from receiving them as intended, the members were enabled to pay an evening visit to the Electrical Standards Laboratory, Whitehall, on February 19th. Before the members dispersed, their thanks to Mr. C. W. S. Crawley and Mr. J. Rennie, who had kindly shown them round, were cordially expressed. Mr. Trotter is giving a paper on "Acceleration and Accelerometers" before the Institution to-day, and on March 10th the Institution's annual conversazione takes place at the Westminster Palace Hotel, when one of the special features of the evening will be an exhibition of engineering and scientific models, specimens, &c.

Tramway and Light Railway Association.—On Tuesday Prof. Carus-Wilson lectured on "Radial Trucks."

At Hanley, at a recent meeting of the English Ceramic Society,

Mr. C. H. Yeaman, borough electrical engineer, read a paper on "Electricity as a Motive Power," with special reference to the industries of the Potteries district.

At the meeting of the Glasgow Association of Students of the Institution of Civil Engineers last week, Mr. F. Sykes read a paper on "Electric Signalling."

The course of University extension lectures on "Electricity in its Modern Applications," which has just been brought to a conclusion at Darlington, has been commercially a failure, and the attendance was most disappointing.

Appointments Vacant.—Shift engineer for Gillingham. (32s. 6d.); electrical and mechanical engineer (at £350); also a traffic manager (£200) for Walthamstow.

Orling Electro-Capillary Recorder.—In our issue of August 19th, 1904, we gave a description of the apparatus devised by Mr. Axel Orling for the recording of submarine cable signals received on his electro-capillary detector, by photographic means. Since that date Mr. Orling has succeeded in producing a mechanical recorder actuated by the same means, which we illustrate in fig. 1. The principle of the apparatus is shown in fig. 2; a light lever L rests upon the top of the column of mercury M, and, when raised by the latter, tilts a little aluminium carrier suspended from a horizontal cord A. The carrier supports a delicate siphon S, the upper end of which dips into a bath of ink, while the lower end faces the tape T, upon which the signal is recorded, the siphon being kept in slight vibration by a thread attached to a vibrator V, consisting of a light spring arm bearing on a moving wheel with a serrated rim.

The receiving circuit is completed between the two bodies of mercury (shown black) through the electrolyte, into which dip the capillary tubes C T, and when a potential difference is established between the terminals, according to the well-known phenomenon, the mercury rises or falls in the capillaries, and, therefore, in the vertical tube. In fig. 1 four capillary tubes are shown, it having been found that the greater number increases the effectiveness of the device.

The instrument is applicable to the recording of wireless signals; fig. 3 shows it connected with Marconi's magnetic receiver; fig. 4 with the Lodge-Muirhead coherer, the resistance of which is decreased by the waves; and fig. 5 with the de Forest electrolytic cell, the resistance of which is increased by the waves.

We have no data as to the working results, but the simplicity and convenience of the device are strong points in its favour, and we shall await further information with interest.

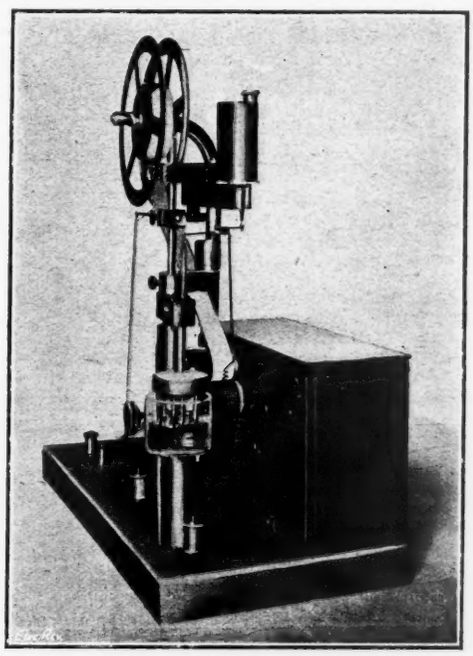

Fig. 1.

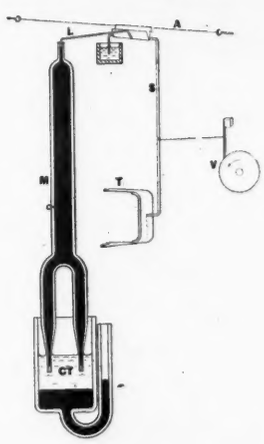

Fig. 2.

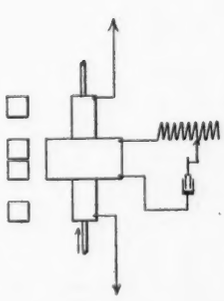

Fig. 3.

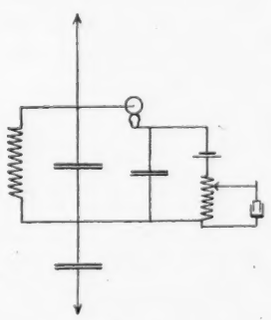

Fig. 4.

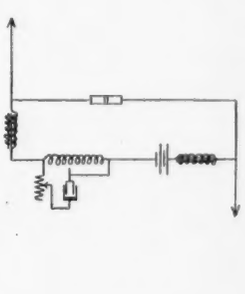

Fig. 5.

Orling Electro-Capillary Recorder.

London Traffic.—On Monday last Vols. V. and VI. of the Report of the Royal Commission on London Traffic were published. They contain about 100 plans, diagrams, &c., with elaborate indexes and references to the evidence in Vols. II. and III. An immense amount of information regarding London traffic conditions is embodied in these volumes, which are largely devoted to statistics, graphic progress charts, &c. While we do not propose to deal with the contents in detail, we may refer to Mr. Stephen Sellon's photographs and data showing the way in which the principal London streets are persistently blocked by standing trade vehicles; Mr. W. Rees Jeffreys also provides photographs illustrating the obstruction due to heavy vehicles in the centre of the road, to lamp and tramway pillars erected in the middle of the roadway, to tramway termini, &c. The deplorable effect of the "local veto" on tramway progress is pointed out.

Only Vol. IV. now remains to be issued, containing the American and Continental evidence. The present volumes are the work of Mr. Lynden Macassey, secretary, and Mr. R. B. Dunwoody, engineer, to the Commission.

The Canal Inquiry.—The Prime Minister hopes shortly to make an announcement regarding the constitution of the Canals Commission and its terms of reference. It is said that the inquiry will, by reason of the terms of reference, have to extend over a prolonged period.

Smelting by Electricity.—The experiments that have been carried out under the auspices of the Canadian Government with the object of ascertaining whether magnetite ores can be smelted by electricity, and whether pig-iron can be desulphurised, have been completely successful. The process is now capable of immediate commercial application, and 40 tons of pig-iron have up to the present been treated, and found of fine quality. Nickel, pig and roasted pyrrhotite have also been produced, and it is predicted that there is a great industrial future for Canada, where ore is cheap and the supply of water-power abundant.—*Exchange Telegraph.*

Faraday House Old Students' Association.—The second annual dinner will be held at the Florence Restaurant, Rupert Street, W., on Friday, March 9th, with the president, Mr. C. D. Taite, borough electrical engineer of Salford, in the chair.

Greenwich Observatory.—In an article in the *Lancet* of Saturday last, complaint was made of the emission of smoke from the chimneys of power stations, and it was alleged that serious damage had been done to the Royal Observatory at Greenwich by the fumes from the L.C.C. tramway power station. As the latter is not yet at work, it is at least open to question whether the complaint is well founded.

The Prospects of Electrical Engineers.—Judging by the statements conveyed in Part 4 of *Harmsworth's Self-Educator*, the electrical industry is a most promising field for young engineers to enter. Those who, for their sins, have been received into municipal employ will be surprised to learn that an attractive feature of that service is "the marked tendency of local authorities to deal liberally with their electrical engineering staff." The author of this remarkable statement—which we can only characterise as a "terminological inexactitude"—goes on to say, "Nor is the tendency surprising, for electric works are often not only very successful in themselves, but highly profitable to the ratepayers." Such examples as Liverpool, Glasgow and Manchester

are cited in support of this assertion, but it is mere quibbling to claim that these exceptional instances prove a rule; the author, however, does not hesitate to say that "on electrical works generally, excluding tramways and their huge gains, no fewer than 115 towns that year made a profit, great or small, amounting in all to £436,000." These highly misleading statements are but samples; the article ("Civil Service," pp. 573-575) holds out most alluring prospects, the author evidently being unaware that the field for trained electrical engineers is notoriously overcrowded, and that the rich profits which he cites exist mainly on paper. It is most regrettable that a wide circulation should thus be given to assertions which have no foundation in fact, tending to delude anxious parents into the belief that by making their sons electrical engineers they will ensure for them a brilliant start in life; the disillusionment will come when it is too late to turn back.

The Cradle of the Deep Electrified.—There is a very ingenious invention, of considerable interest to electrical engineers and others, at present to be seen at work on some of the South-Eastern and Chatham Railway Co.'s steamers between Dover and Calais, for the relief of passengers who suffer from the terrors of sea-sickness. It may be briefly described as follows: "A swinging cot is suspended on gimbals in much the same way as a ship's compass. To the ceiling of the cabin are attached four electric brakes which connect with the four corners of the cot by means of a suitable arrangement of cords and pulleys. When the cot has a tendency to lose its horizontality, one or two of these brakes become active, and so check it until the ship has regained an upright position. The ingenious part of the apparatus is the way in which contact is made so as to apply the brakes at the right moment. This is done by means of mercury contained in four tubes, placed at the bottom of the cot, in the form of a square. When the cot begins to lose its horizontality, the mercury runs down into one or two corners of the tubes, as the case may be, where it completes the circuit and so operates the brakes at the required points." The apparatus is the invention of a London dentist, Mr. Walter Whitehouse. It has been in daily operation for a considerable time, and has proved very successful and of great benefit to passengers using it. We are indebted to Mr. H. P. Bleckly, of Dover, for the foregoing information.

American Tariffs.—According to a Reuter dispatch the Reciprocity Bill, which is said to be favoured by President Roosevelt, was introduced in the House of Representatives on Wednesday. It authorises the President to enter into a commercial agreement with foreign countries to reduce the duties on certain imports for a period not exceeding five years. The reduction mentioned in the Bill is 20 per cent. on the Dingley Tariff, and the Bill also provides for the transfer of other classes of merchandise to the free list.

Electro-galvanising of Iron Wire.—The U.S. Electro-Galvanising Co. of Brooklyn, New York, claim several very distinct advantages for this system over the usual hot galvanising process, and substantiate their statements by the following examples:—

No. 1.—Barb wire, hot galvanised, exposed for two years; very badly rusted.

No. 2.—Hot galvanised wire, exposed five years; entirely rusted to pieces.

No. 3.—Cold, or electro, galvanised wire $\frac{3}{16}$ in. thick used for protecting flower beds, ends being about 6 in. in ground for about one year; in absolutely perfect order.

No. 4.—Cold galvanised $\frac{1}{2}$ in. round bar exposed two and three-quarter years being about 10 in. in ground, having the lightest possible coat applied in 11 minutes especially for testing purposes; in absolutely perfect order.

By the hot process only one thickness of coat is said to be possible—usually three mils. It may be just enough, or it may be too much. By the electro process the thickness can be perfectly regulated according to requirements, and, in addition, the zinc has the enormous advantage of being chemically pure. The Brooklyn Navy yard adopted the system about four years ago, and after a trial extending over three years the results were considered so satisfactory that similar plants were installed at the Norfolk, Boston and Philadelphia yards. This is a matter which should interest many of our readers.

Electric Shock Fatalities.—An inquiry was held at East London recently into the death of a man named Stevens, who had come in contact with a fallen electric wire. Mr. Denham, Government Electrical Engineer, was present. The borough electrical engineer stated that the wire in question carried a current at only 110 volts, but the wire immediately above the broken section carried 500 volts, and the former appears to have sagged and rubbed against the latter, the insulating covering on the upper wire being damaged. Witness was not prepared to say that sagging and subsequent contact of the upper wire with the lower wire had caused the breakage of the latter. At the conclusion of the inquiry, the Magistrate stated that a report would be drawn up, and if the Government agreed it would be published in due course.

A 5,000-volt Direct-Current Generator Set.—Mr. P. G. Nutting, in Bulletin No. 3 of the Bureau of Standards, U.S.A., describes the construction of a 5,000-volt direct-current generator set. Ten 500-volt shunt-wound Crocker-Wheeler generators are mounted with a 2-H.P. driving motor upon a substantial framework running upon "all-way" castor wheels. The motor is belted to a countershaft, which drives the 10 generators by belts. The generators are mounted with the motor upon the varnished oak table-top, this being the only insulation between the bodies. The brush holders and field terminals are insulated by heavy mica bushings, and the armatures are in series, with the fields in parallel, the latter being connected to a 120-volt circuit. By means of a wide-range speed controller the voltage produced, between 3,000 and 5,000 volts, can be kept constant to within 1 per cent. The variable resistance in the high-voltage circuit consists of an amyl alcohol solution of cadmium iodide, which is being replaced, however, by a wire and graphite rheostat. So successful is this high-voltage generator set, that it quite replaces batteries of storage cells for vacuum tube, and even for accurate conductivity tests.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station Engineers.—On the evening of 21st ult., in the new Exhibition Room of the Charing Cross, West End and City Electricity Supply Co., at Fenchurch Street, at a gathering of the station staff, Mr. F. FORREST, late assistant City sub-stations engineer, who has accepted the position of chief sub-stations engineer to the Birmingham Corporation, was presented with a silver plate and cut-glass table centrepiece from the City sub-stations' staff on his resignation.

Mr. H. E. HARMER has been promoted to the post of shift engineer from that of switchboard attendant at the Middlesbrough Corporation electricity supply station.

Mr. J. ARCHIBALD KYLE, A.I.E.E., has taken up a position with the Westminster Electric Supply Corporation, Ltd., as and from March 1st.

The Beckenham U.D.C. has fixed the salary of Mr. J. E. TAPPER, resident electrical engineer, at £275 per annum.

The Faversham T.C. has increased the salary of Mr. SOMERVILLE, electrical engineer, to £200 per annum.

Mr. JAMES K. BOCK is due in London about the middle of March. Acting on his advice the Compania de Electricidad de Cuba, of Habana, has now been sold to the old Gas and Electricity Co.

The Tramway and Lighting Committee of the Johannesburg Town Council have recommended Mr. GIBBS as distribution engineer to the Council at a salary of £840 per annum, subject to his entering into a three years' contract. Mr. Gibbs has, since 1904 been superintending engineer in South Africa for Messrs. W. T. Glover & Co., of Manchester, the contractors for the Johannesburg underground cables.

The Hoylake and West Kirby U.D.C. has, on the recommendation of the Electric Supply Committee, increased the salary of Mr. H. G. MCHAFFIE, the resident electrical engineer, to £320 per annum, in view of the undertaking now showing a balance on the right side.

A local paper says that a marriage has been arranged between Mr. S. E. FEDDEN, general manager of the Sheffield Corporation Electric Supply Department, and Miss Margaret Warwick, second daughter of Mr. and Mrs. Ebden Warwick, of Bedford.

The Bridlington Electricity Committee has appointed Mr. E. FENTON, of York Electricity Works, to be assistant electrical engineer in succession to Mr. SIMPSON, whose resignation has already been referred to in this column.

Mr. G. PARRY, of West Ham Electricity Works, has been appointed charge engineer at Southend generating station. Owing to the resignation of Mr. H. K. ROWE, a shift engineer at Southend, and rearrangement of the staff, Mr. A. WISEMAN, at present engaged at the works, has been appointed switchboard attendant; another switchboard attendant is also to be engaged.

Tramway Officials.—The Rochdale Tramways Committee has recommended the T.C. to grant an honorarium of £600 to Mr. S. S. PLATT, borough surveyor, in respect of services as engineer in connection with the reconstruction of the tramways.

Mr. PILCHER, traffic manager of the Burton-on-Trent tramways, has been appointed manager of the Aberdeen tramways, at a salary of £300 per annum.

Mr. WILLIAM THOM, M.I.E.E., having resigned his position as general manager of the Madras Electric Tramways Co., after eight years' service, leaves for home early in March.

The Highways Committee of the L.C.C. recommends the Council to increase the salary of Mr. J. H. RIDER, electrical engineer, from £1,000 to £1,100 on April 1st, 1906, and to £1,200 a year on April 1st, 1907; that of Mr. J. K. BRUCE, traffic manager, from £800 to £850 per annum; and that of Mr. J. SHEPHERD, assistant electrical engineer, from £500 to £550 on April 1st, and to £600 on April 1st, 1907. The appointment of the following officials is proposed by the Highways Committee of the L.C.C. in connection with the taking over of the northern tramways:—Resident electrical superintendent at £300 a year, rising to £350 by two annual instalments of £25; one district traffic superintendent at £300, advancing to £350; one assistant rolling stock superintendent at £250; and one assistant permanent way engineer at £250 per annum. Three charge engineers are also to be appointed for the Greenwich power station at a salary of £250 a year.

(*Continued on page* 349.)

THE WORKS OF MESSRS. VERITYS, LTD., AT ASTON.

As our readers are probably aware, we have from time to time had occasion to describe in these columns the more prominent electrical manufacturing works in this country, devoted to the production of the heavier classes of plant; but many years have elapsed since we dealt with the operations of a firm of electrical manufacturers and suppliers, whose products are of direct interest to the consumer, to whom fittings, radiators, fans or motors, are naturally a first concern.

Fig. 1.—View in the Armature Winding Department.

For this reason, and because no such account has yet appeared, we believe that our readers will welcome the following description of Messrs. Veritys' works at Aston, the products of which have justly obtained a world-wide reputation.

The firm, originally established in Covent Garden, London, in 1826, in the early days of gas engineering, was one of the first in this country to turn its attention to electrical work, the rapid growth of which soon rendered the acquisition of larger works a necessity.

In 1890, the principal part of the manufacturing business was transferred to Plume Works, Aston, the site of which adjoins the Birmingham and Fazeley Canal, but the further development of the firm's operations led to the erection of extensions consisting of a large adjoining block of buildings known as the Victoria Works. The business was converted by the late Mr. John Verity into a limited liability company, under its present title, in the year 1896, and Mr. George Verity, his brother, is the present chairman.

The buildings, as a whole, closely conform in plan to the shape of the letter **E**, about one-half of which represents the older works, three floors in height, and the other half, the newer portion which is four floors in height. The works comprise four separate departments, dealing with (*a*) motors and fans; (*b*) switches and controllers; (*c*) arc lamps, and (*d*) fittings. These departments are worked independently, each having its manager and office staff: the first three are housed in the new block, and our attention was in the first instance directed to the motor and fan department, located

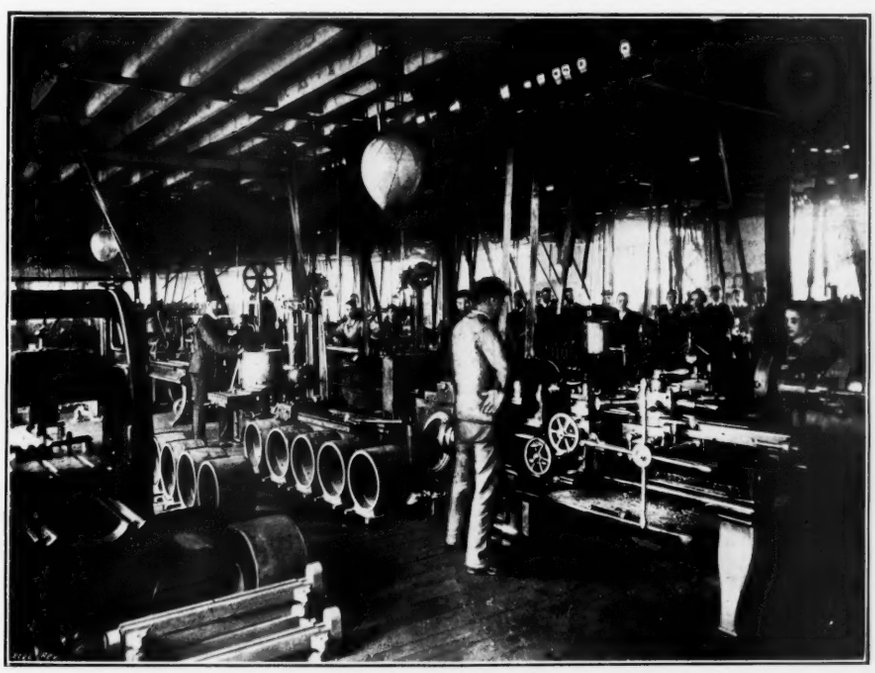

Fig. 2.—The Light Machine Shop: Motor Department.

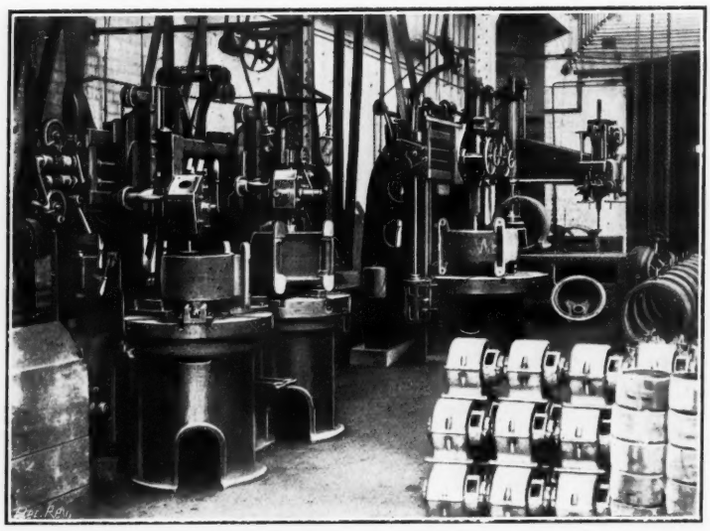

Fig. 3.—The Heavy Machine Shop.

on the ground and first floors of the building. Here the well-known Aston D.C. motors and dynamos, in sizes ranging from $\frac{1}{20}$ to 40 H.P., are turned out in large numbers, all built to gauge and in standard sizes, also machines of the Lundell type, for which this firm are licensees: worm and back-geared sets are made in large quantities, especially the former.

Every description of electric fan, from the small pedestal and punkah types to the large air propeller, ranging up to 72 in. diameter, is turned out by this department.

With a view to keeping fully abreast of the times, the firm have introduced a series of interpolar motors, which we illustrate and describe on a later page.

The fan business has been largely developed by the firm, who are supplying at the rate of 250 per week at the present time, and largely to the Indian market, where the punkah type of motor-driven fan with its balanced wooden blades, neat self-oiling bearings and noiseless action is much appreciated. Fig. 5 is a view in the fan department.

The ground floor includes shops devoted to the erecting and testing departments, together with certain of the heavier machine tools, which are shown in fig. 3 and include a Webster and Bennet double-boring mill, and a similar single 5 ft. Niles mill whereon the larger magnet frames are bored and turned, planing and radial drilling machines, &c., all of which are motor-driven.

The test bed (fig. 9) at the time of our visit was fully occupied by motors and fans undergoing test; an extensive range of testing equipment is provided, both direct and alternating current at various voltages being available from the works power plant, which is, however, supplemented by a supply from the public mains.

The power plant is situated in an engine room immediately behind the test switchboard. It includes an Ashton-Frost compound condensing Corliss engine of 300 H.P., driving two 80-KW. 110-volt generators, for supplying either side of the three-wire system adopted in the works.

A 25-H.P. motor-driven alternator, working up to 5,000-volt pressure, and used for flashing tests on the adjoining bed, and a 500 or 1,000-volt double-ended D.C. testing generator, are also installed, together with the main power and lighting switchboard, in the engine room.

Adjoining the erecting shop is the press and turret department, of which a view is shown in fig. 10; the press plays a most important part in the firm's operations, dealing as they do largely with repetition work, and its equipment of a dozen or so large and numerous smaller machines is utilised for stamping out armature core plates, pole-pieces and tips, commutator sections, fan-blades, sheet metal-work such as scrolls, leaves, &c., for the fittings department, and mica insulations.

Fig. 4.—A Corner of the Switch Department

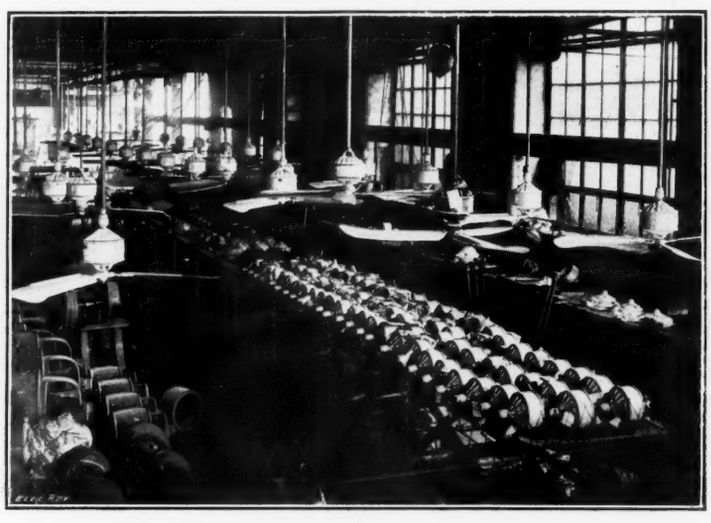

Fig. 5.—View of the Fan Erecting and Testing Shop.

One small press, we noted, turns out miniature brass nuts at the rate of 350 gross per hour.

For the curving and shaping of fan blades and similar work, drop hammers with special dies are used.

The turret and automatic lathes, of both English and American make, range in size down to the toy-like, though perfect, little tool for producing $\frac{1}{16}$-in. diameter screws, and supply the bolts, studs, screws and similar material required in the various operations carried out in the works.

Two other interesting departments are located near the erecting shop—viz., the impregnating and enamelling shops. The former contains two sets of vacuum-drying apparatus, in which the impregnation and subsequent drying-out of the insulation for the machine windings is carried out. The firm's practice, it may be noted, is to treat the individual coils, and subsequently, the completed armature. In the enamelling shop, the smaller fan and motor parts are expeditiously dipped in the enamelling bath, allowed to drain, and subsequently baked in a gas oven.

Fig. 6.—Arc Lamp Assembling.

On the first floor of the new block are situated the light machine, commutator-building and armature-winding shops. The tool equipment of the former department, which we illustrate in fig. 2, is very complete, its numerous turret and ordinary pattern lathes, drilling, milling, grinding, &c., machines, being specially adapted for the small repetition work, which is a necessary feature of production in large quantities.

In the commutator department, the assembling of commutators direct and entirely from stampings is carried on: in the adjoining armature winding section, shown in fig. 1, in addition to the building of armatures for the Aston motors and dynamos, there can be seen the winding of numerous miniature armatures for the fan motors. The latter work is peculiarly adapted to female labour, and the numerous girls in this department also wind, tape and form the coils for the larger armatures.

Our next move was to the switch and controller department, fig. 4, which occupies the second and part of the third floors of the new building, and in which Messrs. Veritys' numerous specialities in switch work are produced. The latter work embraces anything from a main switchboard to a tumbler switch, and includes many popular types of hand and automatic motor starters, circuit-breakers, ironclad switches, feeder pillars for lighting and tramway work, switch fuses and resistances.

Fig. 7.—View in the Lamp Test Room.

In the switch department, equally with the others, the improvement of existing types of apparatus and evolution of new ones was much to the fore: we noted the ingenious Cyclax slow-speed motor-starter, which has recently been brought out by Messrs. Veritys, and which is referred to later: a new type of knife switch, which possesses obvious constructive advantages from both a maker's and user's point of view, and improved types of Peard switch and ironclad fuses, which will shortly be issued by the firm.

The second floor is equipped on one side with a variety of small tools, many of them automatic, and suited to the special requirements of switch making: the other side is utilised

Fig. 8.—One Side of the Crucible Foundry.

as to a fitting and assembling department. Enamelled slate strips are here sawn into the desired sizes for switch bases, being subsequently accurately drilled to template in multiple drilling machines, for the reception of the fittings.

The switch blades are mostly cut from copper bar of the correct section, other fittings being either stampings or the product of the automatic tools.

The Aston starters, which form a staple product here, are arranged so that any part which may have to be removed can be detached from the front, and the rear connections are in every way accessible.

The winding of wire resistance spirals is also a feature of this department, the spirals being, as a rule, subsequently stretched round porcelain frames of various standard forms, the amount of resistance varying with the length of stretch given to the spiral. In the "Bengal" type of regulator, which has been specially designed for use with punkah-type fans in India, separate resistance units, each consisting of a porcelain section with resistance spiral stretched over it, are employed—these units are locked in the switch base and the spring contacts made by simply fastening on the cover, a simple arrangement which has obvious advantages.

The Aston fan regulators are a most important item in this department, some thousands being in hand at the time of our visit.

It may be noted that where Messrs. Veritys employ laminated switch contacts these are of the straight type bearing on a bevelled terminal—the renewal of such contacts is well within the scope of any mechanic.

The switch department is provided with a special test room, where ohmic, insulation and flash tests are made on the various apparatus before it leaves the department.

In the top floor of the same building is housed the arc lamp department, views of which are given in figs. 6½ and 7, where the well-known Aston-Worsley arc lamp is turned out in quantity.

The principal output is in single, twin and long-burning (400-hour) enclosed arcs, but the open and other types of arc lamp are also supplied in large numbers, together with the ingenious arc lamp hoisting and contact gears specialised in by the firm.

In this department, as elsewhere, every effort has been made to secure cheap and rapid production and interchangeability; to this end, it may be noted, that a uniform frame and mechanism suffices for the three types of enclosed lamp referred to, but slight modification being necessary to accommodate the single, twin and triple carbons employed therein, and the substitution of different coils and cores providing for both direct and alternate current lamps.

At the time of our visit, a large number of orders for both direct and

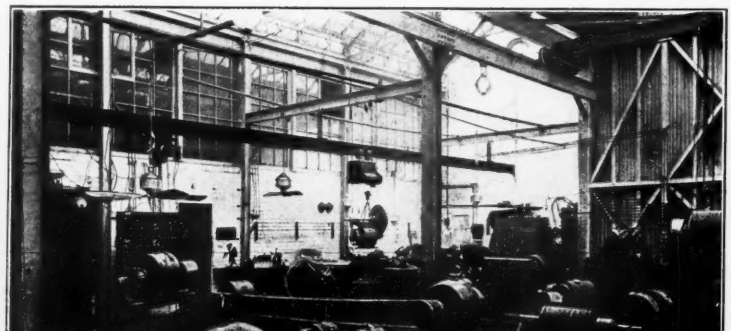

Fig. 9.—The Motor Test Bed.

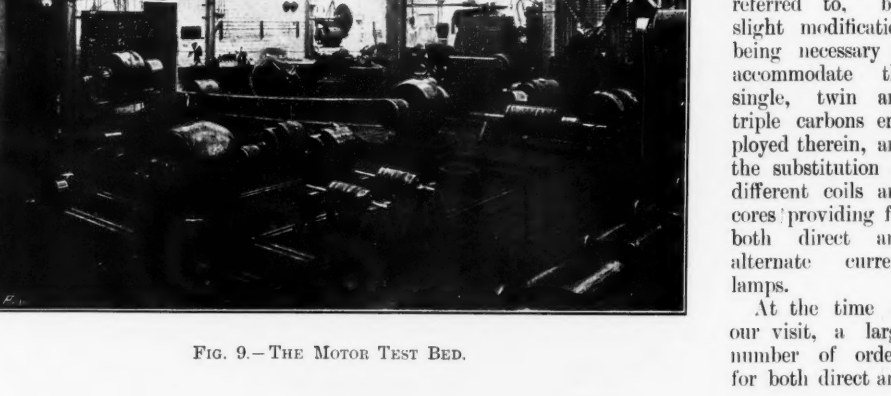

Fig. 10.—View of the Press and Turret Shop.

alternating current lamps were in hand, one order alone representing 212 enclosed type lamps.

The equipment of the department included a variety of small turret lathes and sensitive multiple drills, small lathes, driven by the foot or power as desired, these being peculiarly adapted for the special class of work which includes the truing up of dash pots, pistons, brake wheels, &c.

Other operations carried out by the department are the winding of shunt and main coils and resistances for lamp work, the making up of copper and zinc cases for covering the arc mechanism and substitutional resistances, the ornamental part of the case being shaped in the spinning department, which is housed in the older works.

A considerable section of the floor is, of course, devoted to assembling the lamps, which are subsequently tested in the test room provided for the purpose.

The test-room equipment includes a B.T.-H. alternator, belt-driven from an Aston motor, from which lamps can be run on frequencies varying from 25 to 125.

(*To be concluded.*)

OUR PERSONAL COLUMN.

(*Continued from page* 344.)

Croydon Borough Council, which from June 1st next takes over the sole control of the local tramways from the B.E.T., spent two hours on Monday night in debating the managership question. The Tramways Committee proposed the appointment of Mr. T. B. Goodyer, manager for the present lessees since the electrification about six years ago, at £600 per annum. Alderman Trumble moved that Mr. Goodyer be offered the post at £500, and, failing its acceptance, the appointment be advertised at £450 per annum. He pointed out that the borough electrical engineer (Mr. A. C. Cramb) looked after the electrical plant, and the borough road surveyor (Mr. E. F. Morgan) was responsible for the up-keep of the track. Consequently, it only needed someone to manage the traffic and staff. Pursuing this argument further, Councillor Peck asked why £600 a year should be paid for a glorified ganger. As a parallel with Croydon, the case of West Ham was cited, where the manager receives £450. Answering this point, Councillor Mabey, who claimed to have some special knowledge of West Ham, said he would be very sorry to see the manager's department in Croydon costing what it did there. He was against a new man learning the business at the expense of his employers, the ratepayers. Councillor Leighton declared that Mr. Goodyer had pledged his sole and undivided loyalty to the Corporation should he obtain the post; that he would "cut the painter," and "have no more truck" with the B.E.T. One argument against the Committee was that this proposed salary would be greatly in excess of that of other officials of the Corporation whose responsibilities were greater. It was also urged that the Council had been given no information as to what the under officials of the tramways department would want. In the end the amendment was carried by a large majority. Then the Mayor accepted a proposition that the post should be advertised at £450; and while this was under discussion the chairman of the Tramways Committee (Councillor Stapleton) stated, to the great surprise of the Council, that information had reached him that Mr. Goodyer would be content with £500. However, the debate continued, and the amendment was lost. Finally, the whole question was referred back, the Committee being instructed to bring up a full and complete scheme as to the future working of the tramways. Meanwhile the Council stands committed to nothing.

On Saturday last a gathering of the Swindon Corporation Tramway employés was held at the G.W. Railway Station to bid farewell to Mr. S. Sumner, who has been appointed to the position of inspector on the Dartford Light Railways. On the previous evening Mr. Sumner, who had been connected with tramway work since the opening of the Bristol tramways in 1895, was presented with a silver watch.

General.—The Sussex staff of the National Telephone Co. have presented to Mr. F. W. Taylor, the district manager for Sussex, a service of plate as a mark of appreciation of the uniform courtesy extended by him to all grades of the staff.

Mr. A. J. Walker, the electrical inspector of the Auckland Fire Underwriters' Association, has been appointed chief electrical inspector for the colony in the service of the New Zealand Underwriters' Association.

Mr. J. R. Maltbie is visiting England on behalf of the American National Civic Federation, to gather information as to the respective merits of private and public ownership of public utilities. He will be joined by Mr. W. J. Clark, of the General Electric Co.

The *Review of the River Plate* says that Messrs. Vail and Bocquet, director and manager respectively of La Capital and other tramway companies, left Buenos Ayres for England toward the end of January.

Obituary.—On Tuesday Prof. S. P. Langley, the well-known American scientist, died, aged 72. While his researches covered a wide field of physics, astronomy, aero-dynamics, &c., his name is perhaps most familiar to the electrician as that of the inventor of the bolometer, an adaptation of the Wheatstone bridge to the detection and measurement of excessively feeble heat rays. Prof. Langley experimented for 20 years with aero-planes, and succeeded in making a model which flew for a mile unassisted; last year he appeared to be on the verge of success, but his 50-H.P. aero-plane was twice wrecked through defects in the launching gear, and was never really tested, the funds available having been exhausted.

NEW COMPANIES REGISTERED.

Foundries, Ltd. (87,564).—This company was registered on February 12th, with a capital of £1,500 in £1 shares (500 6 per cent. cumulative preference), to adopt an agreement with E. J. Clamp, to take over the business referred to therein, heretofore carried on by the North London Engineering Co., Ltd., and to carry on the business of engineers, founders, electricians, electric light and power contractors, telephone and telegraph manufacturers, &c. The first subscribers (each with one share) are:—E. J. Clamp, 19, The Circus, Greenwich, S.E., electrical engineer; J. Mark, 7, Willoughby Park Road, Tottenham, mechanical engineer; B. H. Clamp, Charlton, 26, Fairlawn Road, Wimbledon, managing clerk; M. A. Tookey, 19, Old Queen Street, Westminster, consulting engineer; E. Paine, 15, St. George's Road, Westcombe Park, S.E., electrical engineer; G. Frampton, 29, Old Queen Street, Westminster, consulting engineer; and F. R. C. Rouse, 53, St. George's Road, Regent's Park, N.W., electrical engineer. No initial public issue. The number of directors is not to be less than two nor more than five; the first are E. J. Clamp (managing director), and others to be appointed by the subscribers. E. J. Clamp is to receive £200 per annum as managing director, in addition to any remuneration to which he may be entitled as an ordinary director.

Filter Band Machine Co., Ltd. (87,563).—This company was registered on February 12th, with a capital of £4,000 in £1 shares, to acquire the benefit of certain inventions relating to improved filtering apparatus for the extraction of liquid from finely crushed minerals or the like, and improvements in and relating to the electrolytical extraction of metals from solutions, and the patents granted in respect thereof, to adopt an agreement with J. F. Webb, and to develop and turn to account the said inventions. The first subscribers (each with one share) are:—G. Smith, 42, Moston Road, N., secretary; E. Amy Willies, 15, Birchdale Road, Forest Gate, shorthand writer; F. A. H. Walker, Downham, Billericay, cashier; A. S. Jordan, 30, Sixth Avenue, Westcombe Park, W., clerk; G. E. Bird, 15, Benedict Road, Brixton, S.W., clerk; H. A. Davies, 16, St. Helens Place, E.C., engineer; and J. R. M. Glencross, 23, Old Buildings, Lincoln's Inn, W.C., barrister. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are E. Coventry, 1, Corn Exchange Chambers, E.C.; Col. G. Clarke, 8, Grange Park, Ealing, W., and W. Norman-Bott, 16, St. Helens Place, E.C.; W. Norman-Bott is nominated by J. F. Webb, and may retain office so long as the said J. F. Webb holds 200 of the 2,200 shares allotted to him under the purchase agreement; remuneration, £30 each per annum (chairman £10 extra). Registered office, 16, St. Helens Place, E.C.

S. W. Luttrell & Co., Ltd. (87,591).—This company was registered on February 14th, with a capital of £75 in £5 shares, to enter into contracts for the construction of railways, tramways and public or private works of any kind, to apply for provisional orders or Bills for the construction of light or other railways, tramways, electric light generating and power stations, telegraph and telephone lines and the like, to own lands, mines, omnibuses, carriage and electrical or other works, &c. The first subscribers are:—S. F. Shaples, 11, Victoria Street, S.W., naval architect, 2 shares; Mrs. M. Godden, 14, Coleherne Road, South Kensington, S.W., 4 shares; H. L. Godden, 20, Moorgate Street, E.C., civil engineer, 2 shares; P. M. Holloway, 12, Lyndhurst Gardens, Tunbridge Wells, gentleman, 1 share; P. H. Pearson, 35, Spring Street, Hyde Park, civil engineer, 4 shares; B. W. Western, Perry-Mead, Bath, civil engineer, 1 share; and J. C. Hailey, 194, Gresham House, Old Broad Street, E.C., clerk, 1 share. No initial public issue. Registered without articles of association. Registered office, 20, Moorgate Street, E.C.

Deeside and District Electric Supply Co., Ltd. (6,107).—This company was registered in Edinburgh on February 16th, with a capital of £10,000 in £1 shares, to acquire from Lowdon Bros. & Co., electrical engineers, of Dundee, Edinburgh and elsewhere the ground, buildings, plant and machinery of the Cults Electricity Supply Station, Aberdeenshire, and to carry on the same and the business of electrical and mechanical engineers, &c. The first subscribers (each with five shares) are:—E. J. B. Lowdon, Temple Electric Works, Dundee, electrical engineer; K. Lowdon, Temple Electric Works, Dundee, electrical engineer; J. Laing, Marine Villa, Aberdeen, consulting engineer; F. J. Scott, 129, Union Street, Aberdeen, solicitor; A. Morrison, 129, Union Street, Aberdeen, advocate; W. Kydd, 9A, Ward Road, Dundee, chartered accountant: and G. Keay, Temple Mills, Dundee, mill furnisher. The number of directors is not to be less than two nor more than five; the first are E. J. B. Lowdon, K. Lowdon and J. Laing; qualification, 250 shares; remuneration as fixed by the company. Registered office, 129, Union Street, Aberdeen.

Riley Y Cia, Ltd. (87,570).—This company was registered on February 12th, with a capital of £20,000 in £1 shares (15,000 preference), to carry on the business of electrical engineers and manufacturers, constructors, repairers, maintainers and runners of installations, wires, cables and other works for the supply and distribution of electricity for light, heat and motive power, and for the working of railways, tramways, &c. The first subscribers (each with one share) are:—R. G. Laws, 51, Mount Stuart Square, Cardiff, stockbroker; G. Willie, Farway, Roath Lake W., Cardiff, accountant; E. Willie, 20, Claude Road, Cardiff, manager; H. Churchard, 102, Strathnairn Street, Cardiff, clerk; R. Baxter, 5, Dalcross street, Cardiff, clerk; C. E. H. Donges, 68, Alfred Street, Cardiff, clerk; and G. T. Llewellyn, 57, Strathnairn Street, Cardiff, stockbroker. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, 100 shares; remuneration, 10 per cent of the net profits remaining after 6 per cent. dividend has been paid on the preference and 10 per cent. on the ordinary shares, divisible.

Mutual Electricity Supply Co., Ltd. (87,621).—This company was registered on February 16th, with a capital of £20,000 in £1 shares. to carry on the business of electricians, engineers, producers of and dealers in electricity for motive power and light, &c. The first subscribers (each with one share) are:—E. J. Cox, 318, Kennington Park Road, S.E., electrical engineer; J. Kimber, 11, Bush Lane House, Cannon Street, E.C., railway contractor; H. W. Everitt, Sunny Side, Beaumont Road, Chiswick, electrical engineer; E. C. Bromley, 24-26, Holborn, E.C., engineer; A. Willett, Rossmoyne, New Malden, clerk; H. J. King-Potter, Oldfields, Horley, advertising agent; and J. Child, 1, King's Bench Walk, Temple, E.C., law stationer. No initial public issue. The number of directors is not to be less than three nor more than eight; the subscribers are to appoint the first; qualification (except first directors), £100 shares; remuneration, £150 each per annum (chairman £50 extra). Registered office, 39, Victoria Street, Westminster.

Institute for Physical Therapy, Ltd. (87,568).—This company was registered on February 12th, with a capital of £100 in £1 shares, to carry on the practice of electrotherapy, photo-thermotherapy, sismotheraphy, hydrotherapy, and massage, and to deal in electrical and medical apparatus and hygienic specialities, &c. The first subscribers (each with one share) are:—D. R. de Simone, M.D., 68, Doughty Street, W.C.; Miss S. Santilli, 31, Old Compton Street, W.; M. G. de Simone, 31, Old Compton Street, W., mechanical engineer; A. Riding, Trafalgar Buildings, Charing Cross, S.W., secretary; A. Bruno, Trafalgar Buildings, Charing Cross, S.W., secretary; A. R. Grierbach, Hazeldene, Tatsfield, Surrey, accountant; and G. Rayson, 23, Kellett Road, Brixton, S.W., clerk. No initial public issue. The first directors are not named.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Supply Co. of Victoria, Ltd. (66,059).—A memorandum of satisfaction in full of charges dated October 1st, 1901, March 10th, 1904, and December 8th, 1904, securing £100,000, has been filed.

South Metropolitan Electric Light and Power Co., Ltd. (47,875).—Issue, on January 31st, of a £10,000 4½ per cent. debenture, part of series created by resolutions of July 3rd, 1900, and May 6th, 1905, to secure not more than the amount of the paid-up capital. Property charged: The company's undertaking and property, present and future, including uncalled capital. Trustees: H. R. Beeton, 18, Austin Friars, E.C.; and W. R. Davies, 10, Moorgate Street, E.C. Previously issued of same series: £210,000.

Provincial Tramways Co., Ltd. (6,445).—Issue, on January 26th, of £20,500 4 per cent. debentures, part of series created May 27th, 1904, to secure £125,000, charged on the company's undertaking and property, present and future. No trustees. Previously issued of same series: £86,000.

Auto-Electric Rifle and Target Co., Ltd., London.—Issue, on February 7th, of £150 7 per cent. debentures, part of series created December 5th, 1904, to secure £5,000, charged on the company's undertaking and property, present and future. No trustees. Previously issued of same series: £2,950.

Bath and District Light Railway Co., Ltd. (76,989).—This company's annual return was filed on February 12th, when 11,270 shares had been taken up and paid for in full out of a nominal capital of £225,000 in £1 shares. Mortgages and charges: Nil.

N. S. Electric Storage Co., Ltd. (75,623).—This company's annual return was filed on January 13th, when 17,367 "A," 16,835 "B," and 2,000 "C" had been taken up out of a nominal capital of £21,100 in 20,000 "A" shares of £1 each, and 20,000 "B" and 2,000 "C" shares of 1s. each. £1 per share has been called up on 16,007 "A" and 1s. per share on 15,475 "B" and 2,000 "C" shares, resulting in the receipt of £16,630 15s. £250 remains in arrears. £1,428 is considered as paid on 1,360 "A" and 1,360 "B" shares. Mortgages and charges: £6,800.

British Railway Traffic and Electric Co., Ltd. (74,227).—This company's annual return was filed on January 11th, when 60,000 shares had been taken up out of a nominal capital of £100,000 in £1 shares. £1 per share has been called up on 7, 10s. per share on 5,000, and 6s. per share on 54,993 shares, resulting in the receipt of £19,004 18s. Mortgages and charges: Nil.

British Westinghouse Electric Co., Ltd. (29,334).—This company's annual return was filed on February 1st, when 18,955 preference and 27,500 ordinary shares had been taken up out of a nominal capital of £600,000 in 30,000 preference and 30,000 ordinary shares of £10 each. £10 per share has been called up on 3,155 preference, resulting in the receipt of £31,550. £433,000 is considered as paid on 15,800 preference and 27,500 ordinary. Mortgages and charges: Nil.

Simplex Steel Conduit Co., Ltd. (56,684).—This company's annual return was filed on February 12th, when the entire capital had been taken up and paid for in full out of a nominal capital of £25,000 in £1 shares. Mortgages and charges: Nil.

Delagoa Bay Development Corporation, Ltd. (76,099).—This company's annual return was filed on January 18th, when 267,400 shares had been taken up out of a nominal capital of £300,000 in £1 shares. £177,440 has been received, including £40 paid on 100 forfeited shares. £90,000 is considered as paid. Mortgages and charges: £180,000.

National Electric Engineering Co., Ltd. (42,605).—This company's annual return was filed on February 2nd, when 2,659 shares had been taken up out of a nominal capital of £5,000 in £1 shares. £654 has been received, and £2,005 is considered as paid. Mortgages and charges: Nil.

Thompson, Ritchie & Co., Ltd. (35,835).—This company's annual return was filed on February 8th, when 200 preference and 140 ordinary shares had been taken up out of a nominal capital of £5,000 in 200 preference and 300 ordinary shares of £10 each. £10 per share has been called up on 170 shares, and £1,700 has been received. 170 shares are considered as fully paid. Mortgages and charges: £1,900.

Automatic Electrical Advertising Syndicate, Ltd. (62,115).—This company's annual return was filed on January 16th, when the entire capital of £4,500 in £1 shares had been taken up. £3,000 has been received, and £1,500 is considered as paid. Mortgages and charges: Nil.

Bryant Trading Syndicate, Ltd. (67,051).—This company's annual return was filed on January 24th, when 17,252 ordinary and 60 preference shares had been taken up out of a nominal capital of £25,000 in 20,000 ordinary and £5,000 preference shares of £1 each. £1 per share has been called up on 13,812, resulting in the receipt of £10,779 11s. £3,032 9s. remains in arrears. 3,500 shares are considered as fully paid. Mortgages and charges: £2,389 13s. 4d.

Anglo-Spanish Electricity Co., Ltd. (62,655).—This company's annual return was filed on January 24th, when 7 shares had been taken up out of a nominal capital of £100 in £1 shares. No calls have been made. Mortgages and charges: Nil.

Gardner Electric Drill and Hammer Co., Ltd. (66,796).—This company's annual return was filed on Janury 24th, when the entire capital of £40,000 in £1 shares had been taken up. £2,000 has been received, and £38,000 is considered as paid. Mortgages and charges: Nil.

Geneva Tramways Co., Ltd. (72,081).—This company's annual return was filed on January 6th, when the entire capital of £850,000 in £1 shares had been taken up. £2,507 has been received, and £847,493 is considered as paid. Mortgages and charges: £889,692.7s. 9d.

Gilbert Arc Lamp Co., Ltd. (52,679).—This company's annual return (made up to January 12th) was filed on January 6th, when 1,405 shares had been taken up out of a nominal capital of £2,000 in £1 shares. £1 per share has been called up on 705, resulting in the receipt of £700. £5 remains in arrears. 700 shares are considered as fully paid. Mortgages and charges: Nil.

Costa Rica Electric Light and Traction, Co., Ltd. (56,447).—This company's annual return was filed on January 11th, when the entire capital of £130,000 in £1 shares has been taken up. £7 has been received, and £120,993 is considered as paid. Mortgages and charges: £167,100.

CITY NOTES.

Baker Street and Waterloo Railway Co.

The half-yearly general meeting of the shareholders of this company was held on Thursday of last week at the Cannon Street Hotel, Mr. T. J. Hare presiding.

In proposing the adoption of the report, the Chairman first referred with regret to the loss the company had sustained in the death of Mr. Yerkes. Mr. Yerkes, after amassing a very large fortune in America, came over to this country and devoted his great experience and energy to the development of the London Underground Railways. At that time they were rather under a cloud because of the vibration troubles which beset the Central London Railway. Mr. Yerkes saw that that trouble was not inherent to the electric railways, but arose from a faulty construction of the locomotives. He brought forward a big scheme for electrifying the whole of the underground railways of London, and when that was finally completed it would be of the greatest value to the people of London. Turning to their own report, £288,000 share and £96,000 loan capital remained uncreated, and they would ask the shareholders to authorise the issue of those amounts, the greater part of which would be required to meet their liabilities under the construction contract. The actual capital expenditure during the half-year amounted to £341,683, and £7,937 for rents, interest, &c., deducted from capital expenditure in June and December, 1901, had been written back and placed to a suspense account, making a total charge for capital of £349,620. The estimate of further capital expenditure amounted to £990,085, and to meet that they had capital powers and other assets amounting to £1,073,085. The line from Baker Street to Kennington Road together with the depôt at St. George's Circus was now completed and ready for the Board of Trade inspection, which was to take place on the following day. It was intended to open that section of the line for public traffic at 1 o'clock on Saturday afternoon, March 10th. They would, doubtless, be interested in hearing some details of the equipment of the railway. The motive power would be electricity, supplied from the great power house in Lot's Road, Chelsea, belonging to the Underground Electric Railway Co. Special attention had been given to the question of preventing the possibility of collisions, and the up and the down rails had been laid in separate tunnels. Improvements had been introduced into the signalling by a system which comprised both automatic and semi-automatic working, and a complete scheme of inter-locking had been provided, and there was an automatic stop which prevented a train from running past a danger signal. The risk of fire had been reduced to a minimum. The station platforms were constructed of concrete and iron, and the permanent way sleepers were of Jarrah and Australian wood, which was practically non-flammable. The rolling stock was built almost entirely of steel, the small quantity of wood used in its construction having been rendered non-flammable. Special lights had been provided for the tunnels at intervals of 40 ft., the current for which was supplied by wires entirely independent of the current which lit the trains. In the case of a train being brought to a standstill in the tunnel, the power would be at once cut off, and the passengers would be able to walk the few hundred yards to the nearest station along a safe and well-lit footway. The ventilation arrangements were most perfect. The automatic signalling, to which he had referred, would enable them to run a frequent and regular service of trains, and in every respect the board had adopted the many improvements which science and practical experience had introduced into the working of electric railways in the last year or two. Experimental trains had been running for some weeks, and they would be glad to hear that the road bed ran exceptionally smoothly, and that vibration could scarcely be detected, even with the most delicate instruments. Their short piece of line to the Elephant and Castle station should be ready for opening in a few months. That would be the southern terminus of the line, but there would be a subway connecting with the City and South London Railway. As to the northern end of the line, they were very anxious to complete it through to Paddington as quickly as possible, and from Baker Street to Edgware Road the work was being rapidly pushed on with. The portion of the line beyond Edgware Road was included in the construction contract, but no work had yet been done on it, as they had decided to apply to Parliament for power to modify the interchange arrangements with the Great Western Railway. Satisfactory arrangements had been made for the interchange of traffic either by subway or footbridge with the several companies whose lines were crossed by their own. It was a remarkable fact that when all the tube railways now in course of construction were completed, it would be possible, without coming into the open, to travel by means of their line and its connections not only between all the important railway termini, but also within a very short walk of almost every point in London.

Sir Algernon West seconded the motion, which was adopted.

Telegraph Construction and Maintenance Co.

Mr. Wm. Shuter presided at the meeting held at the offices on February 27th. After an appropriate reference to the late Sir Robert Herbert, and to the appointment of himself to the chair, a position in which he would be as devoted to the company's interests as he had always been during his many years' service. It would be a real pleasure and satisfaction to him to have Mr. F. R. Lucas as his joint managing director. Mr. Lucas, like himself, had been "one of us" since the earliest days of the company, and his vast and varied experience in the manufacture of cables and in cable-laying in every part of the globe was of quite a unique character. The year which had just come to a close had been one of exceptional difficulty. The accident which happened to the *Colonia* at Nova Scotia was at first a grave anxiety. Fortunately, the efforts of their officers were successful in getting her off the rocks, and the damage done did not prove so serious as was at first anticipated. She completed the laying of the Atlantic cable, and went into dry dock in London afterwards. She had been thoroughly repaired, and was reclassed by the Board of Trade, and stood at the same at Lloyd's as at her launch. Although the greater part of the loss was covered by insurance, the company would bear part of it. This did not appear in the profit and loss account, as it was a charge against the insurance fund. The accounts for the period were on the whole satisfactory, and compared favourably with those of 1904. In that year the net profit was £48,825 against £73,911 this year. For 1904 the disposable balance was £146,000 against £153,580 on the present accounts. They now proposed to declare a dividend of 10 per cent., making 15 per cent. for the year, and carrying forward £108,760 as against £102,079.

After Mr. Croft had, on behalf of the shareholders, referred to the loss sustained by the death of Sir R. Herbert, and had congratulated the new chairman on his new position, the motion for the adoption of the report and payment of dividend was seconded by Sir James Pender, and carried.

A few explanations of certain items in the accounts were given by the auditor (Mr. Plender).

The retiring director and auditors were re-elected, and a vote of thanks closed the meeting.

Notting Hill Electric Lighting Co.

The meeting was held on Tuesday at 140, High Street, Notting Hill Gate, W., Sir William Crookes, F.R.S. (chairman), presiding.

In moving the adoption of the report (see Electrical Review, February 23rd, 1906), the Chairman remarked that he had much pleasure in again presiding over a meeting of the shareholders of that company, and he had presided over every one of their meetings, with the exception of that of 1896, when he was in South Africa. The accounts showed a very satisfactory result, and it would have been even better had there not been a surprising absence of fogs during November and December. While those who lived in the neighbourhood were glad to be so free, it was a fact that a fog might have made a difference of a £1,000 to the company. The shareholders would notice an item of £785 for Parliamentary expenses. It was the sum incurred in opposing measures during the last session of Parliament, measures, which if passed, would undoubtedly have had an injurious effect on the company's interests. He was glad to say that the opposition was successful, but he felt that it was a genuine grievance that they had had to expend money in protecting what were their statutory rights. Several measures which might lead to competition were being promoted this session, but they had the assurances of the promoters that there was no intention of interfering with the interests of that company. He hoped, therefore, that the amount charged for Parliamentary expenses would be much less this year, and that in the course of time it would have disappeared. Not only the shareholders, but the general public suffered by the company being put to such expenses, for they prevented a general reduction in the price charged for current. They had spent £76 in opposing the rate assessment, and, he was sorry to say that their case had failed, and that they had been advised not to carry the appeal any further. The rating of the individual property of the company had been increased from £4,598 to £7,656, while that of the Wood Lane station had been raised from £3,567 to £5,688. It meant that the company would have to pay over £1,000 a year more in rates, or the enormous sum of £3,600 a year—over 10 per cent. of the total revenue going to the local authority. That was practically the only source which would increase their working expenses. The following figures would show the position of the company in the years 1904 and 1905, and for purposes of comparison he need only give those two years:—

	1904.	1905.
Houses connected increased from	2,267 to	2,486
Lamps " "	132,132 "	143,102
Units sold "	1,645,492 "	1,711,955
Revenue "	£34,563 "	£35,314
Expenses "	14,718 "	15,367
Profits "	19,845 "	19,983
Dividend on ordinary shares	7 per cent. "	7½ per cent.

The company were joining with their neighbours, the Kensington and Knightsbridge Electric Lighting Co., the Westminster Electric Supply Corporation and the St. James' and Pall Mall Electric Light Co., in promoting a Bill to enable the companies to make a close working arrangement, and, if necessary, to erect a generating station somewhere on the banks of the Thames. Satisfactory arrangements had been made. The cost of generating current at the Wood Lane works had now been reduced so much that it was below that of any similar station in London. In spite of the energies of the gas companies, the rate of progress continued satisfactory. New customers were coming to them, and the area of supply had greatly improved on account of the large amount of rebuilding which was taking place in the district. They had a new tariff for current supplied for power, heating or cooking, but they could not see their way to doing as other companies had done and reducing the price to 1d., for that would have been too low. They charged 3d. per unit during one hour, and made a reduction for a maximum quantity taken during 20 hours. A canvass of the neighbourhood was being made, and they would shortly be issuing a monthly periodical setting forth the advantages of electricity as an inducement to customers. There had been some anxiety as to the prospects of electric lighting in London, but he saw no serious reason for alarm. They were quite able to compete with the gas companies, and he did not think that Parliament would consent to any interference with a business in which so many millions of capital had been placed by the public on the moral understanding that they were not to be interfered with. As to a Royal Commission, he would welcome such, for they were ready to meet all demands and supply at a low figure.

Sir R. Biddulph Martin seconded the motion.

In reply to a question, the Chairman said the companies were only taking power to erect a generating station on the banks of the Thames, and there was no intention of doing this at present.

The report was then adopted.

Newcastle-on-Tyne Electric Supply Co.

An extraordinary general meeting was held on 15th ult. at Newcastle, Mr. J. T. Merz presiding, when the Co.'s Bill was approved. Its object primarily was to ratify two agreements that had been entered into (1) with the Northern Counties Co. to take over their Orders and to supply the district which they commanded with electricity; (2) an agreement with the Durham Electric Power Distribution Co. for supplying to them wholesale, in bulk, electricity, which they would then distribute.

Mersey Railway Co.

Mr. Falconer recently presided at a special meeting held at Worcester House, Walbrook, E.C., when the company's Bill for the present Parliamentary session for conferring further powers upon the company was submitted and approved. The objects of the Bill were for an extension of the period limited by the Act of 1900, during which the interest on the debenture stocks of the company other than the new first debenture stock is made contingent upon the profits of each year; it was proposed to extend that for a further period of five years. That provision was in the interests of debenture and shareholders alike. As concerning the ordinary and preference shareholders, it required no recommendation, because it was all in their favour. It was also in favour of the debentureholders; it was really their question, and they had approved of it practically unanimously. The other provision of the Bill was to authorise the company to run motor-omnibuses in connection with its train service. These omnibuses were much needed, and would be a great convenience, not only for the railway passengers, but for the public of Birkenhead, but he would refrain from entering upon any discussion with regard to that, because the Birkenhead Corporation had seen fit to take proceedings for the purpose of raising the question whether the company was entitled to run motor-omnibuses. So far as the company was concerned, there was no doubt that it was a great advantage that this motor-'bus service should be carried on.

A Shareholder asked if the negotiations that were pending with other railway companies for the purchase of the interests of this company were continuing or whether they were in abeyance. He did not wish the chairman to say anything to prejudice the negotiations—he only wanted a hint.

The Chairman, in reply, said that when they were in a position to make any statement on the subject, they would at once do it, but he would only be misleading somebody if he gave a hint one way or the other. Pressed to say whether the negotiations were still proceeding, the chairman said he had given the only possible answer.

Oxford Electric Co.

This company holds its meeting to-day at Oxford.

The directors' report says that the revenue account for the year 1905 shows a profit (including £899 brought forward from last year) of £12,823. After providing £2,103 for debenture and other interest, and writing off £696 on account of hire-purchase installations, the balance available for dividend is £10,024. To pay the dividend of 7 per cent. on the ordinary shares absorbs £6,475; £2,500 is placed to reserve and renewal of plant account, leaving a balance of £1,049 to be carried forward. It is estimated that at December 31st last there was the equivalent of over 73,000 8-c.p. lamps connected to the mains. The number of Board of Trade units sold during 1905 was 8 per cent. larger than in the previous year. The capacity of the generating station has been increased by the provision of a 200-kw. generator and a new boiler; additional coal storage has also been provided. Two transformers have been installed in the sub-stations, increasing the distributing capacity by 80 kw. New sub-stations have been erected and equipped at Union Street and Ship Street, and enlargements and improvements have also been made to the sub-stations at North Parade, Queen Street, and Police Station Passage. The supply mains have been extended in many directions, and the capacity of

the high-tension trunk mains has been largely increased. The whole of the authorised capital of the company having been issued, the directors, in order to provide additional capital for the extension of the undertaking, have resolved to increase the capital by the creation of 10,000 cumulative 5 per cent. preference shares of £5 each, which will, in the first instance, be offered to the shareholders.

Charing Cross, Euston and Hampstead Railway Co.

The half-yearly general meeting of this company was held on Monday, at Hamilton House, Victoria Embankment, E.C., Mr. Cecil A. Grenfell (chairman) presiding. The meeting was private, but our representative was informed that the motion for the adoption of the report was moved by the Chairman and seconded by Mr. F. M. Ogilvy.

We understand that the whole of the tunnelling has now been completed, and that the electrical equipment and rolling stock have been ordered. The line will be opened, it is anticipated, early in 1907. The amount expended during the half-year was £561,783, making a total of £3,934,477.

Kensington and Knightsbridge Electric Lighting Co.

The directors' report, presented at the meeting held yesterday, shows that during the year 1905 the number of houses and shops connected with the system has increased from 3,451 to 3,693, while the number of lamps, calculated on the usual basis of 8 c.p., has increased from 303,048 to 326,827. The renewal account now stands at £57,670, being an increase of £1,738 over the amount of the account at the end of the previous year. After providing for the amount placed to renewal account, writing £346 off cost of purchase of South Kensington Order, in the capital account, and after paying the dividends on the 6 per cent. first preference shares to June 30th, 1905, on the 5 per cent. second preference shares to September 30th, 1905, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1905 is £15,775. Of the above sum, £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £13,650 a further dividend on the ordinary shares at the rate of 10 per cent. per annum for the past half-year, making, with the interim dividend paid on August 1st, 10 per cent. for the year. This will leave a balance of £8,400 to be carried forward. During the year further substantial reductions have been made in the charge for supply, representing a considerable saving to the consumers.

At the last annual meeting the question of the directors' remuneration was reconsidered, and a sum of £750 was voted to the directors by way of additional remuneration for the year then last past, and it was resolved that for the ensuing year, that is for the year 1905, and for the future, their remuneration, instead of being, as in the past, £1,000 per annum, should be £1,750. Objection has since been taken upon the ground that only a few shareholders were present at the meeting at which the change was resolved upon, and that no previous notice had been given that the question would be raised. In these circumstances the directors propose that the question should again be dealt with at the approaching meeting, and a resolution will be submitted for the approval of the shareholders, providing for the confirmation of the resolution of last year, and that the remuneration of the directors shall, until otherwise resolved by the shareholders, be fixed at £1,750 per annum. A shareholder who has a considerable holding in the company's shares is of opinion that the amount named would be unduly large, and has intimated his intention to move a resolution in the following terms:—"That inasmuch as the motion which was carried at the last meeting, when only about a dozen shareholders were present, and of which no notice had been given to increase the directors' remuneration from £1,000 to £1,750 a year, and to be retrospective as regards the preceding year, appears to have been irregular, if not illegal, it be now rescinded."

Westminster Electric Supply Corporation.

The meeting of this company was held on Wednesday at Eccleston Place, Mr. Edmund Boulnois presiding, in the absence of Lord Suffield.

In moving the adoption of the report (see Electrical Review, February 23rd, 1906), the Chairman said that there had been a reduction in the profits. Three factors had primarily conduced to this diminution, viz., the reduction in charges, which had temporarily lowered the income, the increase of rates, and Parliamentary expenses. They would see from the report that on their new valuation there was an increase in rates of not less than £7,000 a year, or over 60 per cent. This took effect from March 31st next, so that they would have to pay over £5,000 more this year than last, which was equal to 1 per cent. dividend on the ordinary shares. Ten years ago their rates were 5s. 3d. in the £; they were now 6s. 10d. on a very much higher assessment. These increasing rates were a serious factor in any business concern, and he feared they could not look for much, if any, improvement, considering the extravagant manner in which local authorities throughout the country were spending money. This handicap must, of course, have an appreciable effect on the possibility, however much desired by the directors, of making further reductions in the charge for supply. In the last few years there had been a great increase in the demand for current for purposes other than lighting, and this demand they had done everything they could to encourage. They were able to supply current for driving motors, heating and cooking, at a cheap rate because the demand for these purposes was spread over much longer hours than the demand for lighting. It was largely the hope of being able to take this business from existing companies which had led to the introduction of so many Bills in Parliament, and therefore to the legal expenses they incurred last year in defending their position. As showing the increase in their business in that direction, he mentioned that they sold last year for these purposes more units than they sold 11 years ago for all purposes combined, and they hoped to be as successful in competing with the gas companies in this class of business as they had been in lighting. Their charge of 1d. a unit for this description of supply came into force on January 1st. This would, he was sure, compare favourably with any of the complex charges proposed by those companies who were seeking to obtain powers to supply for similar purposes in the County of London. The fight in Parliament concerning electricity supply was to be continued this session, and the London County Council had now entered the lists. The Bill they were promoting jointly with other West End companies did not seek to trench upon the rights or powers of any other company, but was a Bill to allow of association for certain definite objects which they considered to be in the interests of the consumer. The question, however, arose as to whether such a matter as the supply of electricity to the metropolis, which was of importance not only to the supply companies, but to the users of electricity and the ratepayers of London, could be properly dealt with piecemeal by means of competing Bills before a Parliamentary Committee, or whether the time had not arrived for the whole subject to be referred to some authority with a wider reference. That companies who were satisfactorily carrying out their duties under powers granted them by Parliament, and under the supervision of the Board of Trade, should year after year be put to heavy expense in defending their position could not be considered equitable, and should certainly be brought to the notice of the House of Commons. They, and other companies also, had made full provision for, and were capable of supplying, any demand they were likely to be called upon to supply in bulk or otherwise. The sanguine estimates of promoters as to the cost at which they could generate electricity under the most favourable conditions were not the only factor which should be taken into consideration in dealing with the supply of electricity in London. The capital which had been already expended under the authority of Parliament, the restrictions under which the existing systems of supply were working, the effect on consumers of the competition which had been allowed in some districts in London, and disallowed in others, and the increased cost due to the purchase clauses, were at least as important. The problem of providing the cheapest and most reliable supply to consumers could never be properly solved unless these factors also were carefully inquired into. Any hasty and partial legislation was quite likely to make matters worse instead of better. Another matter he wished to refer to, was their Millbank Street station. Under the Thames Embankment Improvement Scheme, the London County Council obtained powers to acquire the land on which this station stands, but they were bound to reinstate the company. This matter had been referred to arbitration, which was now proceeding. As stated at the extraordinary general meeting, held in October last, the directors, after full and careful consideration, were of opinion that it was desirable to take steps to provide for raising from time to time in the cheapest way the capital estimated to be necessary for the remainder of their term. The scheme for the conversion of the 5 per cent. preference shares and the issue of 4½ per cent. preference shares had now been carried through. The whole of the issue of 50,000 new 4½ per cent. preference shares was subscribed at a premium of 7s. 6d. per share, and the board thought they could congratulate the shareholders upon the result of a somewhat unique scheme for carrying out the necessary increase in the company's capital.

Mr. J. Browne Martin seconded the motion, and it was carried.

London United Tramways (1901), Ltd.

The report for the year ended December 31st, 1905, states that the gross receipts amount to £301,350, and the working and general expenses and renewals to £175,314, leaving, with the balance brought forward, a net revenue of £126,600. After payment of debenture interest and the dividend on the preference shares for the year, there remains £30,447. An interim dividend at the rate of 4 per cent. per annum, less income-tax, was paid in August, leaving a balance now available of £18,234. It is proposed to pay a final dividend on the ordinary shares for the half-year ended December 31st at the rate of 2 per cent. per annum, less income-tax, to place £10,000 to reserve, and to carry forward £1,116. The sum proposed to be placed to the reserve fund would have enabled the directors to pay a dividend on the ordinary shares of 4 per cent. for the year, but the board feel that the policy of substantially strengthening the reserve fund out of revenue, in addition to maintaining the company's plant and equipment in the highest state of efficiency, will commend itself to the shareholders. The gross receipts show an increase of £5,115, whilst the operating expenses have decreased by £875. The total number of passengers carried was 49,157,139, an increase of 1,030,412. Since the last general meeting the construction of the authorised tramways in Kingston, Surbiton, and New Malden, and between Brentford and Hanwell has been undertaken. The works are practically complete, and it was anticipated that the lines would be approved by the Board of Trade and opened for public traffic on March 1st. The directors intend to proceed immediately with the construction of the tramways from New Malden to Wimbledon, Merton and Tooting. The carrying out of these lines is of paramount importance, inasmuch as when complete they will afford valuable through facilities over the company's system in Middlesex and London and the electric tramways of the London County Council.

National Telephone Co.

The meeting of this company was held on the 22nd ult. at Hamilton House, Sir Henry Fowler, M.P., in the chair.

In proposing the adoption of the report, the Chairman said that the income accrued for the half-year had amounted to £1,125,978, which was an increase over the corresponding period of £92,272. Naturally, the Post Office royalties had increased, the amounts being £95,195 in 1904 and £105,866 this half-year. As showing what a burden these royalties had been to the company, and how largely they had contributed to the public purse, he might say that since the first licence was granted in 1881, they had paid over 2 millions in royalties. With their increased receipts, their working expenses had naturally increased. They had amounted to £647,846, against £591,635—an increase of about £66,000. The net result was that, after deducting the royalties and working expenses, there was a profit of £372,265, being an increase in the half-year of £25,390. After payment of the dividends there was a balance of £134,858, and they proposed to carry £125,000 to the reserve fund, which would leave a balance of £9,858 to be carried forward. Comparing the years 1904 and 1905, the gross income in 1904 was £2,019,000 and in 1905, £2,212,000, showing an increase of £193,380. The profit had been £730,743 in 1905, as against £678,346 in 1904, or an increase of £52,397. At the end of 1904 the reserve fund stood at £1,503,410; it now stood at £1,912,475. They had increased the number of their stations from 315,829 to 362,413 and the staff had been increased from a total of 13,844 to 15,702. The number of messages carried last year was something over 100 millions, while the number of inland telegrams for the same year was 88 millions, so that the telephone service was supplying many more messages than the telegraph. The average receipt per exchange message was a fraction under ½d. The growth of the business was most remarkable — especially in London. A good deal of uneasiness was expressed by some shareholders, when the London agreement was completed, who thought that that agreement would act prejudicially on the business of the company. That, however, had not been the case. When the Metropolitan area came into competition with the Post Office they had 47,053 stations. The Post Office had now been in competition with them for practically four years, and they had got 30,000 stations, but the company's stations had gone up to 72,860, proving the truth of what the board had frequently said, namely, that there was ample room for an extension of the service, and that the arrangement they entered into with the Post Office in 1902 had worked advantageously both for the company and the Post Office and for the public. The principal event of the past year had been the agreement for the sale of the company's property to the Post Office at the end of the year 1911. The sale was, for all practical purposes, a compulsory one as far as they were concerned, as their licence then expired, and they had been given to understand that it would not be renewed. As they were aware, a Committee of the House of Commons very carefully considered the agreement and made certain modifications, the most important of which, and one which the company was very pleased to accept, related to a provision for the bulk of the company's servants when the Government took them over. Nearly all of the employés would be taken over by the Post Office, and would be in the same position as if they had remained in the company's service. As regarded the limited number of their staff to whom those conditions did not apply—those getting salaries of £700 a year and upwards, he was sure it would not be the wish of the shareholders that those valuable servants should be left out in the cold, and to meet their cases the directors proposed to establish a fund out of the revenues of the company to be applied at their discretion in compensating those servants and officials. As to their attitude for the next six years, it was the policy of the board to continue to extend the service and to keep it well up to date. The telephone undertaking was one that could not stand still—it must either go forward or go back. As showing the spirit in which the board approached this question, immediately the House of Commons sanctioned the agreement, they sent their manager, Mr. Gaine, and their engineer-in-chief, Mr. Gill, to America to make an investigation into the latest developments of telephony in the United States. Some people talked as if England was the worst supplied country in the world as regarded telephones. That was not so. As a matter of fact, it was the second best, and what they had always aimed at was to get up to the American standard. As showing the difference in the use of the telephone in London and New York, London with a population of 6½ millions had over 100,000 stations; while New York with about one million less population, had 280,000 stations. He might say in passing that the telephone was dearer in New York than in London. He now had to make an announcement which, he could say without the slightest affectation, gave him great regret, and that was that having been appointed to an office under the Government, he felt it his duty to retire from his membership of that board, and consequently from the chair. He had always taken the deepest interest in the company ever since his connection with it, and quite early he satisfied himself that very great injustice had been done to it by the criticisms levelled against it. The board had at one time been crippled by want of funds from doing all they would have desired, but since they had had the benefit of the London agreement and a freer hand in reference to capital, the company had redressed most of the grievances which had been so loudly complained of. The paid-up capital of the company in 1900 was 7 millions, to-day it was 9½ millions. The expenditure then on capital account was £8,086,000, to-day it was £11,830,000, an increase of 3¾ millions. The reserve fund in 1900 stood at £883,000, to-day it was £1,912,000, all of which had been taken out of the profits of the company. In 1900 the number of stations was 200,000, to-day they numbered 360,000; the staff had increased from 10,000 to 15,700; the gross income from £1,432,000 to £2,212,000, and the Post Office royalties from £140,000 to £206,000. Those figures, he thought, reflected some credit upon those who had had the financial and administrative management of the company, and it was with real regret that he severed his connection with it.

Mr. G. Franklin, in seconding the motion, said he was sure that all the shareholders would agree that the retirement of Sir Henry Fowler from the company would be a very great loss.

The report was adopted.

Subsequently a special meeting was held, when resolutions were agreed to converting 90,000 ordinary shares into preferred and deferred stock.

W. T. Henley's Telegraph Works Co.

The directors' report submitted at the meeting held yesterday, says that the accounts show that during the year a net profit has been made of £50,100. After payment of directors' and auditors' fees, debenture interest and expenses of issuing new debenture stock, and making sufficient allowance for depreciation of buildings, plant, machinery, &c., there remains £40,187, making, with £26,512, brought forward from last year, a total of £66,698. The directors have transferred £5,000 to the reserve account and recommend the payment of a dividend on the ordinary shares of 15 per cent. (less income-tax), of which an interim dividend of 5 per cent. was paid on September 1st last. These payments will, together with the preference dividend for the year, amount to £44,000, leaving a balance of £22,698 to be carried forward. To meet the growing requirements of the business £300,000 new debenture stock has been created. Of this stock £150,000 has been issued, and the former debenture stock has been redeemed. The whole of the expense of this issue has been charged against the accounts for this year. The construction of the Gravesend Works is approaching completion, and it is expected that manufacturing will commence there in the course of a few weeks.

Blackpool and Fleetwood Tramway Co.

The meeting of this company was held last Friday at Manchester, Mr. George Richardson presided. The report for the half-year showed that, including the sum brought forward from the previous account, the balance of profit, after providing for debenture interest, was £9,537; and the directors recommended a dividend at the rate of 9 per cent. per annum, which absorbed £6,750, writing off a sum of £750 for depreciation reserve, and transferring £250 to general reserve account, leaving a balance of £1,787 to be carried forward.

In moving the adoption of the report, the Chairman said it was not so satisfactory as the directors had hoped. The falling off in the receipts for the past half-year was readily accounted for. The motor meet on the Blackpool Promenade was responsible for a portion; it diverted the traffic from the trams, and there was likewise a falling off in the traffic receipts from Fleetwood, arising from a shortness of labour at the docks. The local traffic showed a steady increase, and the directors were looking forward to a busy season. On the expenditure side the increase was brought about by increased rates and taxes. The directors had appealed against the assessment, but without success. The decision of the Court against them was a halting one, and the appeal would be prosecuted in a higher Court, and carried to the House of Lords if necessary.

The report was adopted.

London Electric Supply Corporation.

On the 22nd ult. the ordinary general meeting of this company was held at Winchester House, Mr. R. H. Benson presiding. The Chairman, in moving the adoption of the report (see Electrical Review, February 16th), said that, during a period of nine years, the units sold by the company had increased from 2,279,000 in 1897 to 13,000,000 in 1905, the cost per unit had fallen from 3·55d. to 0·95d.; the gross revenue had increased from £50,000 to £130,000, the net revenue had advanced from £16,570 to £78,721, and the capital expenditure, which was £800,000 in 1897, amounted last year to £1,065,000. The power business of the company began in a very small way in 1903, whereas in the past year 59 per cent. of the units sold were for power, as distinguished from lighting purposes. They were prepared to meet any demand for power in their area as defined by Act of Parliament. Last year they earned 10 per cent. on their capital and paid 3 per cent. on the ordinary shares, and put the balance to the reserve fund, increasing it to £25,000, and a contingency account was started of £5,000. They had in the past year earned rather more than 13 per cent., and they proposed to pay a dividend of 4 per cent. After paying £1,946 for exceptionally heavy Parliamentary expenses which they were put to last year, they were going to double both the reserve and contingency funds, which would leave them at £50,000 and £10,000 respectively, and they would carry forward £3,141, as against £2,000 brought in. Those results had been accomplished in the face of severe competition, besides decreasing prices. There were no fewer than 11 different competitors, of whom two were borough councils. For the borough councils they had offered to do the Council's lighting business cheaper than they were doing it themselves, but the offer was refused. Some of the shareholders might think that another £3,000 could have been spared to pay a dividend of 5 per cent., but those who urged that course, were referred to past sacrifices when no dividend was paid on the ordinary shares for 18 years up

to 1904, and the capital had been written down £227,000, making the shares £3 instead of £5. Those sacrifices were constantly in the minds of the directors, whose object was to retrieve their position, and the only way in their opinion was to pile up the reserve fund now that they had the money to do it so as to strengthen the company physically and financially, to husband their resources, and to improve their credit. If profits increased as they were doing, they would soon be able to pay larger dividends. Negotiations for what was the largest and most important contract which had ever been let in the City, were nearly completed. Although the agreement was not signed, there was every reason to believe that they were agreed on all points. An issue of capital would be made to the shareholders as soon as the contract was completed to provide the extra capital for new plant, &c. Last year £42,000 was spent on capital account, but not a single debenture share had been sold against it, and on December 31st they had £59,000 cash assets, as against £39,000 cash liabilities. The contract with the L.C.C. had been renewed for another three years at the expiration of the present one. At present the Council were taking more power from them than ever, but when their generating station was completed the L.C.C. would not be lost to them for at least three years, and perhaps not then. At their station at Deptford they could produce power cheaper than anywhere in the County of London, and that was the strength of their position. They could sell power at ¾d. per unit to any large consumer who would keep their plant running continuously and not intermittently, and they were even prepared to sell it at ½d. per unit to any consumer who would keep their power going for 24 hours per day. In 1904 the total cost of production upon sales of 10,500,000 units was 1·21d. per unit against the 1·76d. of all the other London companies, while last year on a sale of 13,000,000 units the total cost was down to ·95, or under a penny, being the lowest of any company. Their works cost, without rates and taxes, distribution expenses, &c., was ·62d. per unit, and their works cost per unit generated was under ½d. When they sold 20, 30, 40, or 50 million units they would cheapen their cost of production indefinitely and be able to reduce the price to the public. In conclusion, he said that the Administrative County of London Bill and other Bills were coming up again this year in Parliament, and they would have to fight the same battle over again as they did last year.

Sir Wm. Preece seconded the motion, and the report was adopted.

South Metropolitan Electric Light and Power Co.

Mr. H. St. John Winkworth presided on Monday at the meeting held at Winchester House.

In moving the adoption of the report (see Electrical Review, Feb. 23rd, p. 307), after referring to the loss they had suffered by the death of the late chairman, Sir John Willox, the chairman, said that the business continued to make steady progress. The lamp connections had increased by 17,283, which, with the exception of last year, when the Crystal Palace area was taken over, was the largest increase they had had, and it made the total 125,674 of 8 c.p. The consumers had increased to 2,858, and the net revenue from £16,574, to £22,131, which latter figure included a full year's working of the Crystal Palace area, as compared with 6¼ months in the previous year's accounts. This, added to the amount brought forward from last year, made a total of £28,838. After deducting debenture and other interest and interim dividend on preference shares, there remained a balance of £17,885, which was to be dealt with as stated in the report. After payment of the dividends proposed, the directors had placed £4,000 to the credit of depreciation account, as compared with £2,250 last year, making the amount of this account £8,500. £3,500 has been placed to reserve account, £1,745 had been applied in reduction of preliminary expenses account, and the amount carried forward has been increased from £6,706 to £7,748, so that altogether an amount of over £10,000 had been set aside during the year. There had also been written off other capital assets, a further sum of £53,079 as referred to in the report. The purchase of the Crystal Palace District Electric Supply Co. had now been completed. The works in connection with this area had been carried out during the year, and the company was reaping the benefit of a more economical supply to that district. The public had also benefited by a more efficient and reliable service and at a lower price, and many of the consumers had expressed themselves as well satisfied with the present supply. The demand for power continued to increase, and in order to foster this important branch of their business, the directors decided to make substantial reductions in price as from the beginning of last year. The full benefit of the extra business which was expected to result from these concessions was, to a large extent, postponed owing to many power users deciding to delay the adoption of electric energy for their works until they saw the result of the Power Bills which were being promoted in Parliament, and to a general misunderstanding of the terms upon which supply would be available if these Bills passed. It was extensively advertised that electric energy would be supplied for power at ½d. per unit; whereas, the lowest price scheduled in any of the Bills was ½d. per unit plus a dead rent of £1 per quarter for each kilowatt demanded, which, in the case of a reasonable load factor, would make the price 1½d. per unit. The South Metropolitan Electric Light and Power Co. had extensively notified likely consumers that they could obtain from this company an immediate and cheap supply of energy, and negotiations were proceeding for several extensions of existing orders and other large contracts for power, which rendered necessary the increase of their generating machinery. Before proceeding with the new engine and boiler house, which they were erecting under the terms of the Company's Act of 1903, and which would not be the subject of purchase by the local authority, their managing director (who, in this capacity, had always acted as the company's engineer-in-chief) visited several of the principal generating stations in this country and on the Continent, and the new power house they were erecting combined all the most up-to-date improvements, which the directors believed would enable the company to produce energy on a large scale at a price which would compare favourably with other generating stations in London. Several Bills affecting the company were being introduced into Parliament in the ensuing session, which were receiving careful attention in order to safeguard shareholders' interests, and the directors were promoting a Bill which was not intended to be in any sense an aggressive Bill, but sought power to make agreements with other authorised users for mutual assistance, and for the giving or taking of supply in bulk, and also to supply railways. He could not say whether Parliament would sanction the Bill, but if power to make agreements were authorised, it would enable the companies to co-operate by joining up their areas of supply, whereby considerable economies could be effected; this, in his opinion, would be much more in the interest of the public than the granting of fresh powers, which must result in a duplication of works and unnecessary breaking up of streets, for which the public would ultimately have to pay. The power asked for would not only assist the directors in providing a satisfactory return upon the capital invested in the undertaking, but also help in the continuance of their policy of making reductions in price from time to time as the demand for energy increased. He felt it was most desirable that the cost of electric light should, as soon as possible, be so reduced as to bring its advantages within the reach of the large industrial population throughout the company's area of supply, which embraced about one-fifth of the County of London south of the River Thames and certain areas beyond, and if the electric supply companies were left alone the directors confidently believed this would, a little later on, become possible as the demand for power increased. The prospects of business during the present year were encouraging.

Mr. H. W. Bowden, M.Inst.C.E., M.I.E.E., the managing director, in seconding the adoption, said that in analysing the figures and comparing them with the previous year it should be borne in mind that they had only six months' working of the Crystal Palace Co.'s area in 1904. Steady progress had been made both in regard to lighting and power, but it would, in his opinion, be idle to deny the wisdom of a sound and prudent policy in view of last year's events. He referred to the threatened invasion of their area by the Administrative Company. Although starting in a comparatively small way the company had consistently cultivated power and had from time to time, as the costs had been reduced, lowered the price for both lighting and power. The units sold for power in 1904 were 38·5 per cent. of the total (for the Northern area about 50 per cent.), and for the last year 40·5 per cent. From the information at his disposal this was, he believed, the highest percentage of any London company, exclusive of the special supply given by two companies for the London County Council trams. The average price obtained in the year 1904 was 4·25d., and in 1905 it was 3·74d. The lighting units were 1,380,699, and the power units 863,617 = 2,144,316, being an increase of over half a million units sold. The capacity of the station was 30,000 kw. The price to be charged for transformed energy was rather less than ½d. per unit. The first instalment for their own new building was two 1,500-kw. turbo-generators, and the next instalment should be two 3,500-kw.; total, 10,000 kw. This plant would complete the first portion, or north section, of a 30,000-kw. (normal) power house; maximum, 60,000 h.p. The capital cost for the first instalment, viz., two 1,500-kw.—was about £16 per kw., which included two 42-in. river-circulating water-pipes, sufficient for the first portion—viz., 10,000 kw.—for which the capital cost would be approximately £11 per kw. The figures given in the report showed simply and clearly the progress of the company, but for those members who would like further particulars he would mention that for the combined stations the comparison was as follows per unit sold:—Coal for 1905, ·54d. against ·7d. for 1904; works costs, ·85d. against 1·06d. for 1904; total costs, 1·48d. against 1·8d. for 1904; efficiency of distribution, 80 per cent. against 78 per cent. for 1904. The inquiries already received regarding a bulk supply since starting the erection of the new power house spoke well for the future, providing they were in a position to generate at the lowest possible cost, and had been obtained from regular consumers—by that he meant apart from any temporary supply for L.C.C. trams. They had negotiations pending for nearly 1,000 kw., part of which would be for new consumers, part for extensions to existing installations, and part for supply in bulk (under their 1903 Act) at the boundary. In addition to the above, they had been asked to quote for a supply of 1,000 kw. to two consumers (total, 2,000 kw.). The demand for electric power was rapidly increasing, and apart from the two special consumers referred to, they ought to be in a position to meet this demand and to quote such rates as would not only secure new customers, but retain the present ones. The board had therefore decided, after careful consideration, to extend the present station, which had an available capacity of approximately 2,300 kw. (the maximum load on this station last year being about 1,400 kw.) exclusive of the emergency or factory load, which might be anything up to a further 400 kw. Having this object in view, he visited several stations, and it was decided to extend on the lines of the new St. Denis power house, Paris, which was, so far as he was aware, one of the very latest and most up to date, erected for the purpose of supplying cheap electric energy for the Metropolitan Railways of Paris, and to afford a supply in bulk to the electric lighting stations as their concessions run out. The site was at St. Denis on the Seine, a suburb of Paris, where there was an

abundant supply of cooling water for condensing purposes, this they had every hope of doing. The whole of the several works in progress were under contract to be finished by June next, being subject to a heavy penalty for non-completion, and when finished should be one of the most efficient power houses in London. With their new station they expected to be in a position to generate for the same output and load-factor at as low a rate, if not lower than any other company in London. The company's station was situated within a few hundred yards of the site scheduled by the Administrative Co. last year, and it was very advantageously situated for cheap production of electrical energy, having a large area of freehold land available for extensions, with river-side wharf for the cheap unloading of fuel, and an abundance of water for condensing, whereas many of the other stations in London which were restricted to the area of the parish or local authority where the powers were granted were obliged to erect stations within that area, and consequently were not possessed of the same advantages. It would, therefore, appear reasonable to anticipate that it would be more economical for them in the future to co-operate with other companies who were more advantageously situated, rather than to expend further capital on generating plant at their own stations.

Col. Pearson asked for information on one or two points in the accounts. The balance-sheet showed that £422,777 had been expended up to the end of 1905, and this included £22,158, the sum paid to the debenture-holders for extinguishing their rights. He ventured to believe that it would have been better to have deducted this sum from the total so that the capital account would then have stood at £400,000, and they would still have kept that £22,158 on the asset side and have gradually written it off year by year. He thought an effort should be made to keep the item of sundry debtors for current supplied at not more than a quarter in arrear. The year's income was £35,000, but the item stood at £14,603.

The Chairman explained that the Christmas quarter was the heaviest—£13,500.

Mr. Horace Boot congratulated the directors upon their maiden dividend, although it was only £2,000, but he hoped they would stop spending capital. He had year after year objected to their continuing to increase the capital unless they increased the payment of dividend. It was wrong policy. Their shares were nearly as low as ever, and were likely to continue so unless they shut up the capital account. The speaker entered in detail into the capital increases during a number of years, which had not been accompanied by dividends. If they looked at the depreciation account they would find where the dividend ought to have gone. Although he had held shares from the beginning, he had not had any of the 7 per cent. preference shares offered to him.

Several other gentlemen in the room also said that they had not received the prospectus of these shares.

Mr. Boot said that there must have been neglect on somebody's part. He had worked out the cost of the works per kw., and it was £150. That was far too high. If they watered the capital they could not pay satisfactory dividends. The only people getting any advantage were the preference shareholders. Mr. Boot once more protested against the directors' fees, and said that if the original prospectus had been kept to the shareholders would have had 5 per cent., and perhaps 7 per cent., for the last three or four years. Mr. Boot repeated his demand for the capital account to be closed, returned to the failure of the company to offer him the 7 per cent. preference, said a good word for the Bill under which the company proposed to work in harmony with other companies, and hoped that no more shares would be issued at the exorbitant interest of 7 per cent.

Mr. Kershaw said that Mr. Boot had made out an excellent case for the directors. He referred to the difficulty they had had in the past in getting money even at 7 per cent., but the directors would be bordering on insanity if they issued the balance of that 7 per cent. issue. He thought that Mr. Boot's position at the meetings year after year was derogatory to the interests of the company. Last year he was crying for a dividend on the ordinary shares. This year he had got one, and he told them it ought to have gone to depreciation account.

The Chairman, in reply, said that Colonel Pearson's remark was a question for the auditors. The issue of preference shares was circularised to all shareholders on the register at the time of issue, and shareholders could satisfy themselves by inspecting the post-book at the offices. With regard to capital, it was impossible for them to stand still. By keeping abreast of the times they were able to produce an increasing return on the capital invested. For the year 1902 the return on the average capital expenditure was 3½ per cent., for 1903 it was 4½ per cent., for 1904 it was 5½ per cent., and for last year it was over 6 per cent., so that the progress was continuous. Although they had spent more money, they were earning more.

The report was unanimously adopted, and the dividend resolution passed. The retiring director and auditors were re-elected, and a Wharncliffe meeting followed, at which the company's Bill was approved. A vote of thanks closed the meeting.

Warrants for dividends on the ordinary and 7 per cent. cumulative preference shares were posted to the shareholders on the 27th ult.

County of Durham Electrical Power Distribution Co.—The directors have recommended dividends for the year ended December 31st, 1905, at the rate of 5 per cent. on the preference and 4 per cent. on the ordinary shares.

Newcastle-upon-Tyne Electric Supply Co.—The directors recommend a further dividend of 5½ per cent., making a total of 8 per cent. for the year 1905. The dividend for 1904 was at the same rate.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—

Malacca Rubber Plantations, Ltd.—95,000 7½ per cent. participating cumulative preference shares of £1 each.

and allow the following securities to be quoted in the Official List:—

Buenos Ayres Lacroze Tramways Co.—5 per cent. first mortgage debenture stock.

Yorkshire (West Riding) Electric Tramway Co.—40,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 110,000; and 46,261 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 46,621.

The Committee have (1) appointed special settling days as under:—

Thursday, March 8th.—W. T. Henley's Telegraph Works Co.—£41,978 4½ per cent. first mortgage debenture stock.

Friday, March 9th.—W. T. Henley's Telegraph Works Co.—Scrip (fully and partly paid) for £108,022 4½ per cent. first mortgage debenture stock.

Wednesday, March 14th.—Shanghai Electric Construction Co.—317 shares of £1,000 each, £200 paid, Nos. 1 to 317.

And (2) ordered the undermentioned securities to be quoted in the Official List:—

United River Plate Telephone Co.—Further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 80,000.

W. T. Henley's Telegraph Works Co.—£41,978 4½ per cent. first mortgage debenture stock, and scrip (partly paid) for £108,022 4½ per cent. first mortgage debenture stock.

Metropolitan Electric Supply Co.—The directors recommend payment of a final dividend for 1905 of 5s. per share on the ordinary shares, making a total distribution for the year of 10s. per share, or 10 per cent., carrying forward £2,219. Last year the dividend was at the same rate.

Brompton and Kensington Electricity Supply Co.—The revenue account for the year ended December 31st shows a balance, subject to audit, of £29,940, making, with the balance brought in from 1904, a total of £35,924. After deducting the balance of interest account, providing dividends on the preference shares, and an interim dividend on the ordinary shares, and placing £8,000 to depreciation account, increasing that account to £57,636, the directors recommend a final dividend on the ordinary shares at the rate of 11 per cent. per annum, making 10 per cent. for the year, carrying forward £8,680. Last year the ordinary dividend was at the same rate, and £5,984 was carried forward.

County of London Electric Supply Co.—The directors, after placing £20,000 to reserve for depreciation and carrying forward over £4,000, recommend a final dividend on the ordinary shares at the rate of 6 per cent. per annum, making 5 per cent. for the year. Last year the dividend was only 4½ per cent.

Scarborough Electric Supply Co.—The report for 1905 states that motive power has been taken by the tramway company during the year beyond the minimum figure agreed upon. The receipts for lighting have suffered from a "bad season" in the town, and also from the reduced scale of charges. Capital outlay during 1905 was £4,636, as against £16,368 for 1904. Capital expenditure may now be considered closed, except for normal extensions. After placing the sum of £1,000 to depreciation account, there is a balance on revenue account of £4,909. The directors recommend a dividend at the rate of 5 per cent. for the year, leaving £171 to be carried forward. For 1904 the dividend was 6 per cent., carrying forward £505.

Dick, Kerr & Co.—An extraordinary general meeting of the shareholders of this company was held on Thursday of last week at the offices, Abchurch Yard, Cannon Street, Mr. John Kerr presiding, when the resolutions sub-dividing the shares, which were carried at the extraordinary general meeting held on February 1st, were confirmed.

Northallerton Electric Light and Power Co.—The annual report shows a profit of £411, from which must be deducted interest on loans and debentures, depreciation on motors, meters, and free-wired installations and commissions, leaving a net profit of £121.

Northampton Electric Light and Power Co.—The annual meeting of this company was held on 20th ult., Mr. F. H. Thornton presiding. The report appeared in the Electrical Review for February 16th. The Chairman said there was an increase in their output of 24 per cent., accompanied by a decrease in the cost of production of 10 per cent. They were enabled to pay the same dividend (5 per cent.) as last year, after paying off £800 to reduce the 6 per cent. preference shares to 5 per cent. They had written off the usual amount for depreciation, which was regarded as satisfactory, for trade had not been so good as it should have been. They hoped that when trade boomed, as they thought it would, the company would do even better. The company had increased very largely the current sold for motor power. New houses were taking electricity, and the main extensions would be very remunerative to them. They found it was a capital thing to go as early as they could to new ground where people were putting up houses. Private householders were beginning to find out the advantages of electric light, and he wished more manufacturers could be induced to share that view. Gas consumed the oxygen of the air, and threw off injurious products. They heard much about the scourge of tuberculosis, and the great remedy for that was pure air. Thanks were accorded the chairman, the secretary (Mr. E. M. Browne, who it was hoped would have a safe voyage home from Japan), the engineer and the staff.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Feb. 24	2,276	+ 95	39	53,296	— 841	..	..
Ayr	,, 17	350	— 5	40	11,909	— 93	8	..
Bath	,, 24	1,174	+ 96	8	4,992	+ 727	13	..
Belfast	,, 23	5,688	+1,380	8	23,121	+ 5,399	40	+ 6½
Birkenhead	,, 25	1,838	— 25	47	48,511	— 606	13·5	..
Blackburn	,, 21	1,625	+ 141	47½	45,542	+ 2,345	13·75	..
Blackpool Corp.	,, 22	639	+ 26	47	47,894	+ 2,020	11·87	..
,, —Fleetw'd	,, 24	369	+ 5	8	1,411	— 34	..	..
,, —Lytham	,, 22	300	+ 19	16	2,407	+ 257	7½	..
Bolton	,, 25	3,587	+ 391	48	91,492	+ 4,664	26	+ 1
Bournemouth	,, 21	2,493	+ 749	46½	65,956	+15,444	17·4	+ 7½
Bradford	,, 24	7,838	+ 404	47	203,943	— 2,579	53	..
Brighton	,, 26	1,398	— 28	48	46,659	..	9·5	..
Bristol	,, 23	9,211	+ 517	..	..	..	28·5	..
Brit. Elec. Trac. Co								
Airdrie	Feb. 16	419	+ 23	7	1,485	+ 145	8·5	..
Barrow	,, 16	410	+ 35	,,	1,329	+ 127	5·37	..
‡Birmingham (City)	,, 16	10,136	— 790	,,	34,547	— 582	14·5	..
Birmingham (Mid.)	,, 16	2,625	— 950	,,	8,967	— 2,292	12·25	..
Devonport	,, 16	773	— 96	,,	2,751	— 178	8·85	..
Dudley—Sto'rb'ge	,, 16	1,456	— 43	,,	4,946	+ 260	21·25	..
Gateshead	,, 16	1,813	+ 59	,,	6,145	+ 362	11·25	..
Gravesend, N'fleet	,, 16	379	+ 3	,,	1,304	+ 74	6·5	..
Greenock	,, 16	1,107	+ 67	,,	3,787	+ 331	7·25	..
Hartlepool	,, 16	490	+ 7	,,	1,692	+ 101	6·72	..
Leamington	,, 16	227	+ 45	,,	855	+ 245	..	..
Merthyr	,, 16	342	— 15	,,	1,145	— 12	2·9	..
‡Metropolitan	,, 16	5,266	+1,268	,,	18,220	+ 5,538	..	..
Middleton	,, 16	520	— 21	,,	1,840	+ 124	8·5	..
Oldham — Ashton	,, 16	986	+ 4	,,	3,365	+ 143	9·13	..
Peterborough	,, 16	185	— 23	,,	642	— 27	5·31	..
Potteries	,, 16	3,432	+ 155	,,	11,562	+ 718	29	..
Rothesay	,, 16	83	— 3	,,	343	+ 43	2·75	..
Southport	,, 16	430	— 43	,,	1,548	+ 42	8·17	..
South Staffs.	,, 16	1,498	+ 148	,,	5,095	+ 855	13·87	..
Swansea	,, 16	1,402	+ 470	,,	4,778	+ 1,759	5·5	..
Tynemouth	,, 16	295	— 48	,,	1,067	— 56	3·75	..
Weston-s-Mare	,, 14	47	— 7	,,	167	— 8	3	..
Wolverhampton D.	,, 16	746	+ 37	,,	2,437	+ 191	14·75	..
‡Worcester	,, 16	447	— 69	,,	1,588	— 79	5·75	..
Yorks. Wool. Dist.	,, 16	1,571	+ 432	,,	5,412	+ 1,896	17	..
Miscellaneous	,, 16	898	— 60	,,	3,015	— 38	..	..
Burnley	,, 24	2,124	+ 275	..	..	..	7·5	..
Burton-on-Trent	,, 25	511	— 56	47	14,368	— 1,631	8·5	..
Bury	,, 18	1,532	..	46	34,989	..	10·5	..
Cardiff	,, 22	3,599	— 49	46	93,643	+ 64	15·8	..
Carlisle	,, 24	231	+ 17	8	1,258	+ 107	..	..
Chatham and Dist.	,, 22	1,063	— 80	8	4,370	— 56	9·3	+ 8
Cheltenham	..	..	..	..	..	..	..	..
Colchester	,, 22	310	+ 1	29	5,333	..	7½	+ ½
Cork	,, 22	784	— 41	8	3,109	— 37	9·9	..
Coventry	Dec. 14	815	+ 8	50	23,960	+ 642	9·89	..
Darlington	Feb. 24	375	+ 23	47	9,531	..	4·87	..
Darwen	,, 23	439	+ 39	47	11,386	+ 703	4·36	..
Dover	,, 24	338	+ 12	47	10,439	+ 71	4·75	+ 1¼
Dublin	,, 23	8,772	+ 284	8	35,164	+ 1,229	48·5	+ ·5
Dundee	,, 21	1,872	+ 319	40	37,755	+ 3,325	12·5	..
East Ham	,, 26	1,504	+ 230	47	38,787	+ 5,417	8	+ ½
Exeter	,, 23	408	..	47	13,094	..	4·25	..
Glasgow	,, 24	30,212	+2,684	38	592,494	+38,907	76	+ 3·5
‡Gloucester	,, 21	221	+ 12	..	..	..	15	..
Halifax	,, 21	2,568	+ 179	47	72,797	+ 5,305	37	+ 1·5
Hastings	,, 23	645	..	..	..	..	..	..
‡Huddersfield	,, 24	1,287	+ 173	47	64,027	+ 3,684	28	..
Hull	,, 24	4,186	+ 135	47	104,796	+ 2,138	13	..
Ilford	,, 24	749	+ 32	47	21,826	+ 981	..	..
Ilkeston	,, 21	221	+ 20	47	5,529	— 681	3·5	..
Ipswich	,, 24	617	— 25	47	19,733	— 1,895	10·5	..
Isle of Thanet	,, 24	445	— 18	8	1,802	..	..	..
Kilmarnock	..	..	..	..	..	..	..	..
Kirkcaldy	,, 21	376	— 9	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 22	1,652	+ 443	8	6,557	+ 1,562	12·5	+ 3·9
Leeds	,, 17	10,769	— 17	47	275,619	+ 8,622	89·5	+ 8
Leicester	,, 24	3,898	+ 388	8	15,610	+ 2,113	..	..
Leith	..	..	..	..	..	..	..	..
Lincoln	..	..	..	..	..	..	..	..
Liverpool	,, 17	19,872	+ 70	7	70,273	+ 2,483	104	+ 1
L.C.C.	,, 10	27,475	+2,058	45	661,784	+88,050	52·5	+ 5·8
Lowestoft	,, 24	218	— 20	21	2,930	— 43	3·5	..
Manchester	,, 24	24,489	+1,862	47	603,401	+30,852	..	..
Nelson	..	..	..	..	..	..	..	..
Newcastle	,, 24	7,174	— 16	47	178,685	+ 4,444	..	..
Newport	,, 17	1,061	+ 95	20	10,933	+ 828	14·5	+ 1·5
Northampton	..	..	..	..	..	..	..	..
Oldham	,, 25	3,046	+ 364	48	77,993	+17,667	23·75	+ 1·6
Plymouth	..	..	..	..	..	..	..	..
Pontypridd	,, 24	288	..	47	7,507	..	3·5	..
Portsmouth	,, 24	2,630	+ 5	47	90,139	+ 1,705	14·5	..
Preston	,, 21	1,155	+ 143	..	..	..	..	..
Reading	,, 22	1,072	+ 18	47	29,267	— 498	..	..
Rochdale	,, 24	1,548	+ 771	47	36,795	+24,187	21·3	+ 5·8
Rotherham	..	..	..	..	..	..	..	..
Salford	,, 19	7,925	+ 260	47	199,678	+11,554	..	..
Sheffield	,, 25	9,712	+ 1,027	48	236,911	+14,201	35·75	-1·5
Southampton	,, 21	1,606	+ 50	20	17,721	+ 17	..	..
Southend-on-Sea	,, 21	451	+ 10	47	17,187	+ 1,041	6	..
Stalyb'dge, Hyde, &c.	,, 17	1,092	+ 226	46	29,175	..	21	..
Stockport	,, 16	1,453	+ 589	46	34,958	+ 9,894	15·5	+ 4
‡Sunderland	,, 18	1,133	+ 53	46	60,710	+ 2,737	..	..
‡Swindon	,, 14	147	— 15	46	8,921	..	4·4	..
Tyneside	,, 14	682	+ 13	7	2,185	+ 45	8·87	..
Wakefield	..	..	..	..	..	..	..	..
‡Warrington	,, 22	339	+ 50	47	16,074	+ 1,064	6·37	+ ·25
West Ham	,, 22	3,620	+1,492	46	86,351	+37,162	14·7	+ 4·9
‡Wolverhampton	,, 14	696	..	..	..	..	10	..
Cen. London Rly.	,, 24	13,993	— 447	8	55,765	— 1,874	6	..
City & S. Lon. Rly.	,, 25	6,016	+ 202	8	24,182	+ 188	6·25	..
Dublin-Lucan Rly.	,, 23	176	— 7	8	669	— 70	7	..
G. N. and City Rly.	,, 25	3,649	+ 124	8	14,472	+ 316	3·5	..
‡'pool Overh'd Rly.	,, 25	2,727	— 122	8	11,098	— 651	6·65	..
Mersey Railway	,, 24	8,450	+ 194	8	13,581	+ 499	4·5	..
Metropolitan Rly.	,, 25	32,572	— 581	8	134,887	— 1,044	70·5	
Met. District Rly.	,, 25	16,595	+ 653	8	65,173	+ 3,661	24	
Anglo-Argentine	,, 25	29,294	+ 3,348	8	116,980	+11,922	..	..
§Brisbane	Jan.	11,616	+ 267	..	5,567	..	..	..
Bu'n's A'r's E.T. Co.	,, 27	2,567	..	4	..	..	..	..
Bu'n's A'r's-Belgr'no	Feb. 11	6,927	+ 686	6	21,182	+ 2,115	..	..
Calcutta	,, 24	5,800	+ 572	..	..	..	..	..
§Cape Electric T. Co.	Jan.	13,306	..	..	..	..	..	..
§Geneva	,,	7,679	..	..	..	..	..	..
§Mexico	,,	61,820	..	..	..	..	..	..
Perth (W.A.)	Feb. 23	2,965	+ 67	8	12,370	+ 588	24·25	+ 5½

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

STOCKS AND SHARES.

Wednesday Evening.

Much ground has to be covered before Stock Exchange business can hope to get fairly under way again. All the various political turmoils, at home and abroad are thorns in the side of finance, and even the City election failed to provide any effective excitement by way of contrast to the dulness of Stock Exchange trade. What few Stock Exchange failures actually occurred were the cause of much less trouble than the shaky accounts which remain behind to clog the wheels of rising markets should such better conditions ever come again, as, of course, they will assuredly do.

Both the old "Underground" stocks are flat, Metropolitans being no better than 79, after touching 77½, and Districts 29¼. The stocks have been a bad market for weeks past, as noticed here with a regularity that has become monotony. In the Stock Exchange the relapse of the last few days is attributed to the breakdowns on the District and the delay in the completion of the Metropolitan's electrification. This latter reason sounds sensible enough, but, as regards District stock, the waterlogged state of the capital account could only be counteracted by vast increases in the traffics, and of such there is little likelihood. Central London Ordinary and Deferred gave way 1 and 2 respectively to 93 and 82½, but the opening of the new Islington to Aldwych tramway has not affected City and South London Ordinary, the price remaining at 42. Waterloo and City continue to advance upon early information as to the three alternatives which will be offered to stockholders by the London and South-Western Railway. The price has risen to 102½, which is a rise equivalent to 3⅝ per cent. Allowing for the dividend, Great Northern and City Preferred shares are ¼ down at 4¾.

With electric railway stocks falling, the shares in the motor-omnibus companies should be moving in the other direction. But they are not, and London Motor-Omnibus have dropped to 1⅝, Motor-'Bus to ⅛ discount, and Districts to 1 1/16. London General Omnibus is flatter than ever.

Traction varieties have barely moved. Cape Electrics are ½ down to 17s. 6d., and London United Tramways Debenture a point to 94½. The slight opposition to the proposals of the Buenos Ayres Grand National Tramways board was brushed aside. How the ordinary holder of the "A" Preference shares likes the idea of losing all his arrears of dividend for the sake of a recompense in Ordinary shares that looks inadequate, we are unable to state. What opinions have reached us on the subject were made more in anger than in measured language. The price is 8 for the "A" Preference, 7¼ for the "B" and 3¼ the Ordinary. British Electric Tractions are down to 7⅜.

Electric Supply issues are still marking time. The County of London Co. declares a dividend, making 5 per cent. for the year, which is an increase of ½ per cent., and likely to prove useful as a lever when the raising of fresh capital comes to the front. The Metropolitan Electric dividend of 5s. a share is at the same rate as that of the corresponding period last year; slight rises in the Preference shares and in the 4½ per cent. Debenture stock are the only changes in the company's prices. London Electrics are ⅛ better, and Westminsters at 11⅛ the same fraction lower. Kensington and Knightsbridge dropped ⅛, to 10. Other alterations are confined to *ex* dividend markings, and are quite colourless. The new Madras Debenture is 5 premium. We hear that the new Tokio Electric Co. may not be out for some weeks yet.

Interest in telegraph stocks is still centred upon the Anglo-American Co.'s varieties. The Deferred stock jumped to 19, and the Preferred has risen 2 points to 114, after being better still. Bright hopes are entertained of the outcome of the present year's cabling business between this country and the other side of the pond. Commercial Cable Debenture has put on ½. Direct United States are ¼ better, and the firm tone of the market generally brought along investment demand for Globe Telegraph Preference, which are ⅛ higher at 14⅞. But Marconi shares remain weak, shedding another 2s. 6d., to 1½.

As a result of the National Telephone Co.'s meeting, the Preferred stock is ½ better at 114½, although the 4 per cent. Debenture is the same amount lower. Sir Henry Fowler's resignation is not expected to place the concern at any disadvantage during its now brief career. If the new capital takes the shape of more 4 per cent. Debenture stock, proprietors may possibly demand that terms are obtained better than those which were made at the time of the last issue of this security.

Manufacturing shares maintain their firm aspect. Brush Ordinary are 15s., an eighth rise, and the 4½ per cent. Debenture stock has recovered most of the deducted interest. Callender's Preference at 5⅞ are also 2s. 6d. up, while Henley's Preference, *ex* 2s. 3d. dividend, have not moved from their last week's price of 5⅜. Dick, Kerr Ordinary rose ¼ upon the splitting proposals, but the good report of the Telegraph Construction Co. has had no effect upon the price of the shares.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905.§	Closing Quotations Feb. 21st.	Closing Quotations Feb. 28th.	Business done week ended Feb. 28th, 1906. Highest	Lowest.	Rise + or Fall —
17,700	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	4 %	98½—101½	98½—101½	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3⅜— 4¼	3⅜— 4¼	..	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	83 — 88	83 — 88	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	23⅝	31½	64 — 66	65 — 67	66⅜	66	+1
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½	6 %	111½—112½	113½—114½	114⅛	112	+2
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½	18⅝— 18⅝	18⅞— 19¼	19¼	18½	+ ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	103 —105	..	..	+1
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	8 — 8½	8 — 8½	..	..	..
1,932,856£	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99	97½— 98½	98⅞	98	..
16,090	Cuba Telegraph	10	6¾%	10 %	5 %	5 %	8½ — 9	8½ — 9	8⅝	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	3⅜— 3⅝	3⅜— 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	8¼— 8⅜	8½— 8⅝	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	99 —102 %	99 —102	..	..	..
60,710£	Direct United States Cable	20	3¾%	3 %	3½%	3¾%	14⅜— 15½	15 — 15¾	15⅝	15	+ ⅛
70,000	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	99 —101	99½—101½	..	..	+ ⅛
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 %	149 —152	149 —152	150⅜	149½	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	91 — 93	91 — 93	92½	91	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	107⅛—109½	107⅛—109½	109	108½	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 %	14⅜— 15½	14⅜— 15½	15 3/16	15	..
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105 —107	105 —107	106⅜	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	101 —103 %	101 —103	..	..	..
180,887	Globe Telegraph and Trust	£3	5¾%	5¾%	5 %	5 %	11⅛— 11⅜	11⅛— 11⅜	11⅜	11⅛	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅜— 14⅝	14⅜— 15	14⅜	14 1/16	+ ⅛
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	..	37 — 39	37½— 39½	..	..	+ ½
42,300	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	100 —102	99½—101½	..	..	— ½
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	5 %	57 — 59	57 — 59	..	..	..
251,127	Marconi's Wireless Telegraph	1	..	..	..	..	1⅛— 1⅜	1 — 1⅛	..	..	— ⅛
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	7/8 — 1	7/8 — 1	..	..	..
86,492	Do. do. 5 % Pref.	1	5 %	5 %	5 %	..	1 — 1	1 — 1	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	113½—114½	114 —115	114½	113½	+ ½
1,966,667	Do. do. Def. Stock	100	4¾%	5 %	5 %	5 %	110 —112	110 —112	111⅛	110	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	13 — 15	13 — 15	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	12⅛	12	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅜— 5⅞	5⅜— 5⅞	5 5/8	..	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	99 —101	99 —101	100⅛	99½	..
1,689,593	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103½—105½	103 —105	104	103	— ½
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¼%	6¼%	6 %	1½— 1⅝	1½— 1⅝	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1½— 1⅝	1½— 1⅝	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 %§	7¼— 7⅜	7¼— 7⅜	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	103 —106	103 —106	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	127 —130	127 —130	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7¼— 7½	7¼— 7½	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5¼— 5⅜	5¼— 5⅜	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	110 —112	110 —112	111½	110½	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9¼— 10	9¼— 10	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	2/8— 3/8	2/8— 3/8	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14½— 15	14½— 15	14⅝	..	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	100 —102	100 —102	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102 —104	102 —104	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	3/8— 5/8	3/8— 5/8	8/9	..	..
84,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	6 %	8½— 8⅝	8½— 8⅝	8 37/39	8⅝	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6½— 7⅛	6½— 7⅛	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	100 —103	100 —103	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 %§	8⅞— 9⅛	8 13/16— 9⅛	9 3/16	* 8⅞	— 1/16
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5¾— 6⅛	5¾— 6⅛	6 1/16	..	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	141 —144	141 —144	142½	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	104 —106	104 —106	105	..	..
800,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	16 %‖	3⅝— 4⅛	3¾— 4⅛	83/11½	80/-	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 1/16— 1 1/16	1 1/16— 1 1/16	30/3	..	..
38,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	..	..	1⅞— 2⅛	2 — 2⅛	..	..	+ ⅛
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	Nil	3/6	5¾— 6	5¾— 6	5 13/16	5 7/8	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	3/-	5 — 5⅛	5 — 5⅛	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2 3/16— 3/16	2 3/16— 3/16	..	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	98 —102	98 —102	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	120 —123	120 —123	121½	..	..
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	110 —113	110 —113	111	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	108 —111	108 —111	..	..	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103 —105 %	103 —105%	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104	102 —105	104⅜	104⅛	+1
133,301	British Electric Traction	10	8 %	6 %	6 %	..	7⅛— 8	7⅞— 8⅛	7 7/8	7 1/16	— ⅛
161,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %§	10 — 10⅛	10 — 10⅛	10 3/8	10 3/16	..
1,415,422£	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	119 —121	119 —121	120⅛	119	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	98 —100	98 —100	98⅛	98¼	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %§	6⅜— 7⅛	6¼— 7	6⅜	..	— ⅛
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %§	5⅞— 6⅛	5⅞— 6⅛	5⅞	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	103 —106	103 —106	104⅛	103½	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	98 —100	98 —100	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1⅞— 2⅛	1⅞— 2⅛	43/9	..	..
1,016,353	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 82	78 — 83	80½	..	+1
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	7/8— 1 1/16	7/8— 1 1/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	..	1½— 1¾	1⅝— 1⅞	16/3	14/3	+ ⅛
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1⅜— 2	1⅜— 2	33/9	..	..
125,000£	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	98 —100	97 — 99 xd	..	..	—1
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3⅜— 3⅝	3⅜— 3⅝	7 7/8	7 5/8	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5⅝— 6⅛	5⅝— 6⅛	5⅞	..	..
27,500	Do. "B" do. 1 to 27,500	5	..	6 %	6 %	..	5¼— 5⅜	5¼— 5⅜	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	105 —107	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 %§	9½— 10	9¾— 10	9 7/8	9 3/8	..
32,610	Do. 105,001to 137,610	5	..	..	..	3d.	9 — 9¼	9 — 9¼	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4 %	4½%	105 —107	105 —107	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	10%	11 — 12	11 — 12	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 6	5 7/8	..	+ ⅛
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108½—110½	108½—110½	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %§	1⅜— 1⅝	1⅜— 1⅝	..	..	— ⅛
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	95 —100	95 —100	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	93 — 95	92 — 94	93⅜	91½	—1
530,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	103 —105	103 —105	104⅛	..	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	83 — 86	81 — 84	82⅛	82⅛	—2
1,480,000	City and South London Railway	Stock	3½%	2⅞%	2½%	1¼%	41 — 43	41 — 43	42⅛	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	..	2 — 2½	2 — 2½	..	..	..
100,000£	Do. 5 % 1st Mort. Deb., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	95 — 98 %	95 — 98	97½	97	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

Continued on next page.)

Perth (W.A.) ..	Feb. 28	2,900	+			

* Compared with the corresponding period of 1905.
‡ Includes horse, steam and other receipts.
† One week only.
§ One month.

upon the price of the shares.

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	§1905.	Closing Quotations Feb. 21st.	Closing Quotations Feb. 28th.	Business done week ended Feb. 28th, 1906. Highest	Lowest.	Rise + or Fall−
		†									
52,000	Dick, Kerr & Co., 1 to 52,000	5	..	..	10 %	..	8¼ — 9	8¾ — 9¼	..	..	+ ¼
61,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	6 — 6½	6 — 6½	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	104 —106	104 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5⅝%	6 %	6 %	13¾— 14⅜ xd	13¾— 14⅜	..	..	..
59,987	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14⅜— 15⅛ xd	14⅜— 15⅛	..	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	4 %	99 —101	99⅜—100½	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½%	3½%	3½%	98 —100	99 —101	..	..	+ 1
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½%	3½%	3½%	97 — 98	97 — 98	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½%§	..	1⅛— 1⅛	1⅛— 1⅛	33/9	..	..
17,189	Do. "A" shares, 01—017,189	5	Nil	Nil	2½%§	..	2½— 3	2½— 3	53/9	..	..
844,023£	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	86 — 88	..	..	..
100,000£	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	⅜— ¾	⅜— ¾	..	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	7 %	7 %	7 %	..	2 — 2⅛	2 — 2⅛	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	89 — 92	89 — 92	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9⅛ — 9⅜	9⅛ — 9⅜	9⅜	9⅛	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	95 — 99	95 — 99	98½	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	4⅛— 5⅛ xd	4⅛— 5	..	..	— ¼
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½— 11½	10⅝— 11¼	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —104	102 —104	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	13 — 14	13 — 14	13¹¹/₁₆	13⅝	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5¼— 5½	5¼— 5½	..	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	.. — ..	.. — ..	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	10%	18 — 19	18 — 19	..	..	..
800,000£	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅝%	1½%	Nil	1⅛— 2⅛	1⅛— 1⅝	..	..	— 1/16
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6½— 7	6½— 7	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	9⅛— 10⅜	9 — 9⅛	..	..	— ⅜
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	3 %	3½— 4⅛	3 — 4	..	..	— ½
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	9 — 9⅜	9 — 9⅛	9⅛	9⅜/16	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	94 — 97	93 — 96	95¾	95	—1
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	..	7/16— 9/32	7/16— 1/2	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	15/16— 1 1/16 xd	1— 1 1/16	20/6	19/3	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	104 —106	104 —106	104½	..	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	4⅜— 5¼	4⅜— 5¼	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8¾— 9¼	8¾— 9¼	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¼— 16 xd	9¼— 10	..	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 — 106	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	34 — 36	34 — 36	35	34	..
150,000£	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	98 —100	98 — 100	..	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3⅛%	3⅛%	3⅛%	3⅛%	99 —102	101 — 104 xd	101	99	+2
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8⅓%	6 %§	..	..	2¼— 2¾	2¼— 2¾	50/-	48/9	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	..	..	4 — 4⅛	4 — 4⅛	86/3	82/6	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	82 — 87	82 — 87	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5⅛%	4 %§	5⅛— 5⅜	5⅛— 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	10 %	8¼— 9⅛	8¼— 9⅛	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	8⅝— 9⅛	8⅝— 9⅛	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	102 —105	102 —105	104	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	5 — 6	5 — 5⅛ xd	..	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	5 — 5⅜ xd	5 — 5⅛	5 1/16	5	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4¼— 4⅝	4¼— 4⅜	..	..	..
40,000	Do. do. 1903	5	..	4½%	4½%	4½%	4¼— 4⅝	4¼— 4⅜	..	..	..
422,900	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —103	101 —103	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5 — 6	5⅛— 5⅜	..	..	..
175,000£	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	10⅜— 11⅞	10⅜— 11⅜	11	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	13¾— 14⅜	13¾— 14⅜	13⅞	..	..
400,000£	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	..	..	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
40,000	County of Durham Electrical Power, Ord.	2	..	..	..	..	1⅞— 2	1⅞— 2	..	..	..
50,000	Do. do. do. 5 % Pref.	5	..	..	..	..	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	8¾— 9⅛	8¾— 9⅛	..	..	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	12⅜— 12⅝	12⅜— 12⅝	..	..	..
400,000£	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	109 —112	109 —112	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —103	101 —103	101¼	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	5 %§	4¾— 5	4¾— 5	95/9	..	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	5⅛— 5⅞	5⅛— 5⅜	..	..	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	104 —106	104 —106	105¼	105	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	4 %§	5¼— 5⅜	5¼— 5⅜	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	8 %	8¼— 8⅜	8¼— 8⅜	..	..	..
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	8 %	8¼— 8⅜	8¼— 8⅜	..	..	..
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —101	98 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	98 —101	98 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½%	12 %	10 %	10 — 11	9¼— 10½	..	..	— ½
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	2¼— 2⅜	2⅜— 2⅝	52/6	51/3	+ ⅛
60,000	Do. do. 6 % Pref...	5	6 %	6 %	6 %	6 %	5⅛— 5⅜	5⅛— 5⅜	..	..	..
374,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8⅓%	10 %	10 %	9 — 10	9 — 10	..	..	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅞— 5⅞	5⅛— 5⅛	5⅛	5⅛	+ 1/16
220,000£	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	110 —114	..	..	+1
250,000£	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	95	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	101 —103 %	101 —103	102⅛	..	..
57,609	Newcastle-on-Tyne, 1 to 57,009	5	..	8 %	8 %	8 %	8 — 8⅛	8 — 8⅛	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	8 %	8 — 8⅛	8 — 8⅛	..	..	..
57,009	Do. 5 % Pref., 1 to 57,009	5	..	5%	5	5 %	6⅛— 6⅜	6⅛— 6⅜	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	5 %	6⅛— 6⅜	6⅛— 6⅜	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½— 14½	13½— 14½	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6½— 7	6½— 7	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	11 — 12	10½— 11½ xd	11⅛	11	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8 xd	..	..	..
150,000£	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	97 — 99	97 — 99	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	2½— 3	2⅞— 2⅞ xd	..	..	..
60,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	76 — 80 xd	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	5	1¾%	3 %	4 %	..	3½— 3⅝	3½— 3⅝	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	2½%	3/16— 1/4	3/16— 1/4	16/6	..	..
85,368	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1½— 1⅝	1½— 1⅝	..	..	..
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	105 —108	105 —108	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	4½— 4⅝	4½— 4⅞	93/9	..	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5 1/16	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	104 —106	104 —106	105⅜	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13 %	10⅜— 11⅜	10⅜— 11½	11⅛	10⅞	— ⅛
28,151	Do do. 4½ % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	5⅜	..	..

Shares not officially quoted :—Mackay Companies, ord., 62½—63½. Pref. 76—77.
† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 4 per cent. (September 28th, 1905).

(Continued on next page.)

PROCEEDINGS OF INSTITUTIONS.

Technical Considerations in Electric Railway Engineering.

By F. W. Carter, M.A., Associate Member.

(*Abstract of Paper read before the* Institution of Electrical Engineers, *London, January 25th*, 1906.)

(*Concluded from page* 317.)

Service Capacity of Motors.

There does not at present appear to be a general agreement as to how railway motors should be rated. The most generally followed rule is that of the Committee of Standardisation of the American Institute of Electrical Engineers, according to which "the commercial rating of a railway motor should be the H.P. output, giving 75° C. rise of temperature above a room temperature of 25° C. after one hour's continuous run at 500 volts terminal pressure, on a stand, with the motor covers removed." The rule was devised to suit the needs of continuous-current tramway motors, and, whilst satisfactory for the purpose of comparing such motors with one another, it furnishes no criterion as to whether the motor will suit a given service.

Amongst manufacturing firms, the General Electric Co., of New York, appear to have developed the investigation of service capacity of railway motors to the greatest degree. The runs of a test are made as far as practicable at constant voltage, constant mean accelerating current, constant time with power on, constant total time between starts, and constant distance run. Accurate records of current and voltage are obtained by means of recording instruments specially designed for this class of work. Temperatures of armature and field coils by resistance, and of field coils and frame by thermometer, are noted hourly, whilst final temperatures of armature core and commutator are ascertained immediately on finishing the run. In expressing the results, it is assumed that the temperature rise will be proportional to the energy loss in the motor, and that otherwise it will depend chiefly on the manner in which the energy loss is distributed between armature and field coils. Accordingly, from the ammeter and voltmeter records the best possible estimate is obtained of the average energy loss in the armature and the field coils, the armature core loss having been previously obtained from stand tests. Curves are plotted from the tests, having as abscissa the ratio of armature loss to field coil loss (the so-called ratio of distribution), and as ordinate the temperature rise per watt loss, one curve being plotted for the armature, and another for the field coils.

In making use of the thermal characteristic curves to determine the temperature rise in a motor proposed for a particular service, the average values of armature and field coil loss are calculated for the cycle of operations which the service involves. From these, the ratio of distribution is deduced; from the thermal characteristics, the temperature rise per watt loss; thence and from the losses we finally obtain the actual temperature rise of both armature and field coils.

The design of the motors should be such that for a service involving frequent stops—where they take the accelerating current for a considerable fraction of the time that power is on—the field coil temperature is the higher, whilst in a service involving much free running the armature temperature should be the limiting feature.

There is not a very large variation in energy loss for different classes of service, and as a first approximation one might affirm that, with a given frame, and a definite arrangement of perforated covers or other heat-dissipating devices, the permissible electrical losses are definite. A motor dynamically capable of a given service will therefore be suitable for continuous use on that service, provided the permissible electrical losses are not exceeded. These losses in a continuous-current railway motor of good design and considerable power usually amount to between 6 and 7 per cent. of the input.

The study of service capacity is of the utmost importance to the designer, who is thereby guided to arrange that the dynamical capacity of a motor shall correspond with its service capacity when used in the class of service for which it is designed, and so to distribute the losses between armature and field coils that they may rise about equally in temperature in average service.

Traffic.

Having finally settled upon the driving equipment and determined the maximum and average power taken by a train, it becomes necessary to make the best possible estimate of the amount of electrically operated traffic upon all parts of the system at all times, in order that the generating and distributing systems may be devised to suit the duty to be imposed upon them. In the case of an entirely new railway, the estimate must be based on knowledge derived from similar ventures elsewhere, modified according to the local circumstances. Where, however, it is in connection with an existing steam-operated system that electrification is contemplated, great assistance can usually be derived from a study of the time-tables of the system.

As a general rule, when the directors of a railway begin to consider electrification, it is with the idea of increasing the passenger-carrying capacity of the system. The limiting conditions should be made the subject of very careful investigation, and the corresponding limits on the electrified system should be estimated as closely as possible.

A very useful curve can be obtained by plotting the number of trains in service as ordinate against time as abscissa. It may be taken as showing the probable general shape of the power house load curve, no account, however, being taken of the variations in load at starting a train or cutting off power.

A well-known and useful method of representing the traffic is by means of a so-called graphical time-table. This is really a system of approximate time-distance curves, distance being plotted as ordinate against time as abscissa for all the trains of the system. It is composed of straight lines joining the several stopping places. We shall employ it as indicating the approximate position of the trains at any time, in order to aid in estimating the probable load on sub-stations and the voltage drop in line conductors.

Distributing System.

In a system of any size there will usually be certain junctions from which several lines radiate, and which accordingly form natural distributing points, where one would locate sub-stations if otherwise practicable. One must also locate a sub-station near each of the ends of a line, since, with the usual arrangement of low-tension feeders, the distance that one can feed to a dead end with a given drop in potential is only about one-third of the distance between adjacent sub-stations on the line.

The above considerations having been taken account of, and local conditions fully allowed for, the sub-stations should be located with reference to the potential drop between sub-stations and trains. In the case of a completely insulated line equipment, the waste of energy limits the mean voltage drop, whilst the necessity of efficient train lighting at all times limits the maximum. With a rail return, however, there is the additional restriction imposed by the Board of Trade on the voltage drop in uninsulated conductors. The worst condition to be anticipated in regular service should be judged, due allowance being made for probable future increase of traffic.

In estimating the capacity of the machinery in the several sub-stations, reference must again be made to the graphical time-tables, from which the number of trains fed by each sub-station at all times can be deduced. A table should be drawn up showing the momentary maximum and average load on each sub-station, both at the time of heaviest traffic and at the time of light load. The output of the sub-station may be taken as 5 per cent. in excess of the input to the trains. The maximum momentary output may generally be taken as occurring when two trains are taking their maximum accelerating current and all other trains that can possibly be supplied from the sub-station are taking their average current, and will correspond with the maximum momentary overload of the machines in use.

In the case of rotary converter sub-stations, the total capacity of the installed machinery will usually be some 40 or 60 per cent. greater than that installed in the generating station for supplying power to the trains. In this respect the transformer sub-stations of a purely alternating current system show to great advantage. Transformers can be designed to stand five or six times the rated load for short periods without injury or excessive voltage drop, and two or three times for an hour or two without excessive heating. In such a system, therefore, the continuous capacity of sub-station plant will usually be less than that of the generating station plant, since the former may be laid out to suit the mean all-day load, whilst the latter must suit the mean load at the time of heaviest traffic.

In a continuous-current system the all-day efficiency of distribution, from generating station bus-bars to trains, is usually in the neighbourhood of 78 per cent. In a well-designed alternating current system this efficiency would probably approximate to 87 per cent.

Generating Plant.

The location of the generating station for a suburban system will be chosen principally from considerations of available sites, suitable sub-soil, and facilities for obtaining water and coal.

The units should be chosen as large as practicable from motives of economy, provided they can be fairly loaded at times of light traffic. At such times the mean load on a unit should not be less than a half of its rated load, even if there are but few trains in service, and may be practically the full rated load if there are a considerable number. The overload capacity of the units may then be depended upon to provide sufficient power for starting the trains.

Having decided upon the size of the unit, we determine the number of units required to handle the heaviest probable load for such time as it is likely to last. These, with one or two additional sets installed as stand-by, will form the main generating plant.

Alternating-Current Working.

The foregoing has been for the most part written round the continuous-current system of operation, and whilst the general method of treatment is independent of the system, there are many considerations having special reference to alternating-current operation, a few of which may well be given here. The most valuable features of alternating-current operation are consequent upon the possibility of supplying power to the trains at high potential. This makes practicable the use of much lighter line conductors than can be employed under continuous-current operation, and also requires fewer sub-stations for a given loss in the line conductor network.

The use of the track or other insulated return circuit for the current requires consideration. The author has no information as to what amount of electrolytic corrosion is to be expected from alternating earth currents as compared with continuous, or what regulations are likely to be imposed to prevent damage by such currents. It is not, however, desirable to impose a limit to the difference of potential between points on the uninsulated return unless the method of measuring the voltage is very precisely set

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out. If the voltmeter be joined to two points in the conductor by pilot wires lying very close to the conductor, the voltage indicated will be little more than the CR drop. The alternating flux due to the current in the conductor will for the most part cut the pilot wire and produce an E.M.F., practically neutralising the reactance drop; thus the indication of the voltmeter will be the difference of potential diminished by this E.M.F. In order to indicate the true difference of potential between points on the conductor, the pilot wire should lie on the surface separating the lines of force which close about the trolley wire from those about the return conductor. This is practically the horizontal plane at a height from the ground equal to half the height of the trolley wire.

The earth currents will be affected in the same manner as the voltmeter current by the varying flux about the conductors. Thus, if a water or other pipe runs parallel to the return conductor, the resultant potential difference tending to produce a current through earth and between two points in the pipe is that which would be indicated by a voltmeter connected to the corresponding two points in the conductor by pilot wires run in the position of the pipe. In the case of a rail return, where the conductor is of magnetic material, the varying lines of force in the iron itself will tend to confine the current to the outside layers of the conductor, and the CR drop will be several times as much for alternating as for continuous current.

Altogether, if earth currents are to be reduced to the same order as is found under continuous-current operation, and it is desired to place the sub-stations as far apart, it will be necessary—taking account of the lower power factor and heavier trains incidental to alternating-current working, in addition to the foregoing considerations—to adopt a line pressure of at least 6,000 volts, or else to install frequent track boosters to take care of the voltage drop in the earthed conductors. If advantage is to be taken of the high pressure to reduce considerably the number of sub-stations, it becomes necessary either to adopt a completely insulated line conductor system, which much increases the difficulty of installation and working at complicated junctions, or to install track boosters, which adds to the expense. The latter will usually be found the most favourable alternative, as it is possible by means of these boosters, which are simple current transformers of ratio unity, entirely to transfer the voltage drop from the uninsulated to the insulated conductor. The best arrangement of boosters is probably that of the Oerlikon Co., in which the track current is transferred by the boosters to a common return conductor running between sub-stations. It is possible, however, to do without the return conductor by connecting the secondaries of the boosters across insulated joints in the track and introducing a small equalising wire, as shown diagrammatically in fig. 5. With this

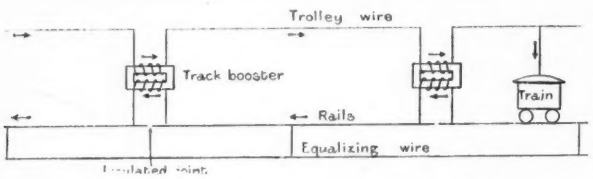

Fig. 5.—Track Booster System for Alternating-Current Operation.

arrangement the track rails are employed as return conductors. The boosters must, however, be closer together near the sub-stations than in the Oerlikon system, and a greater number are accordingly required.

There is much of a general nature to be said in favour of the single-phase alternating-current system, and the author, in common with many others, founded great hopes on its development, believing that it would lead to a considerable increase in the electrical operation of railways. Careful investigation, however, reveals difficulties and disadvantages which compel the conclusion that the single-phase system as at present developed is not suited for a great part of the railway work likely to be required in this country (*i.e.*, urban and suburban work), and, moreover, shows no prospect whatever of being rendered satisfactory for the purpose.

The weak feature of the single-phase system, as applied to this class of work, lies in the driving-motor. This has a much smaller range of power than the continuous-current motor, whilst its electrical efficiency is considerably lower. The compensated series type of motor has a somewhat higher efficiency than the repulsion type—mainly on account of its lower rotor losses. Its efficiency is, however, necessarily lower when operated as an alternating-current motor than when operated as a continuous-current motor, and this again is lower than it would be if the motor were specially designed for continuous-current operation. Moreover, the energy consumption per ton-mile will usually be greater than in the continuous-current system, on account of the lower efficiency and less favourable speed-torque characteristic of the motor. Altogether the electrical losses in the motor are much in excess of those in the continuous-current railway motor, whilst, on account of the more compact internal construction, a motor with a given outside shell will be some 15 or 20 per cent. heavier.

We have seen that the rating of a continuous-current railway motor gives no information as to its service capacity, but is only useful in comparing motors of the same kind with one another. The method of rating the single-phase alternating-current motor is equally arbitrary, and is useless for the purpose of making a service comparison with the continuous-current motor. In suburban service, as we understand it in this country, a single-phase railway motor with a given outside shell has little more than half the service capacity of the continuous-current motor having a similar shell, which in such service is liable to be employed to its utmost capacity. This, we have seen, is equivalent to saying that the electrical losses in the motor are nearly twice as great, as compared with the input, as obtain in the continuous-current system. In suburban service it is practically necessary to employ multiple-unit trains, with the motors geared to the axles of coaches, where they must be capable of operating practically enclosed and without attention for long periods.

The result of the above is that the alternating-current equipment is considerably heavier than the corresponding continuous-current equipment, the increased weight of the train itself requiring more motors. If we charge to equipment weight not only the weight of the motors, transformers, and controlling apparatus, but also the excess of weight of the motor trucks over trailing trucks, and of the heavier underframe required to carry the transformers, &c., it is not too much to say that the single-phase system has an equipment weight per ton from two and a quarter to two and a half times as great as the continuous-current system, whilst an equipped and loaded train of given capacity will be some 30 to 40 per cent. heavier on the former than on the latter system. In the foregoing we refer particularly to the somewhat severe conditions of English suburban service.

What with the heavier train and greater energy consumption per ton-mile, the energy consumption per train-mile, for trains of given capacity, will generally be quite 45 per cent. greater under single-phase than under continuous-current operation. Allowing for the higher efficiency of distribution in the former of these systems, the power and energy generated must still be some 30 per cent. greater. This requires 30 per cent. greater capacity in the generating plant, the cost of which will almost wipe out the saving on the sub-stations, whilst the 30 per cent. greater annual generating costs will far exceed any possible saving in sub-station maintenance and supervision. In a compact system operating frequent trains—such as the usual urban system—the sub-station expenses are insignificant.

A properly installed overhead conductor system, insulated for high potential, will be at least as costly as a third rail, whilst the single-phase train equipments will be two or three times as expensive as the continuous-current equipments for corresponding trains. In fact, taking account of all circumstances, the single-phase system, when compared with the continuous-current system on the basis of equal traffic capacity, costs considerably more to install, and considerably more to operate in the class of service under discussion.

The speed-torque characteristic of the single-phase motor is more suitable for high-speed service with few stops than for suburban service. It would probably be necessary, however, to concentrate the equipment on a locomotive, where the motors might be artificially cooled—a course hardly practicable when they are carried on the axles of the coaches.

Some of the disabilities of the single-phase system disappear at low speeds, where the equipment weight is in any case a smaller fraction of the train weight and its increase therefore of less importance. Again, a service involving infrequent stops and moderate speeds, where the input per ton is small and the motor losses can accordingly be kept within reasonable limits, may often prove quite suitable for operation by the single-phase system. In short, this system shows promise of having extensive but by no means universal application to railway work.

The polyphase system, employing induction motors, has the disadvantage of requiring two or more overhead conductors, which complicates matters considerably at junctions, although it is not so serious an objection on continuous track. It is not well suited for suburban or other service in which stops are frequent and a high rate of acceleration necessary.

The strong feature in the polyphase motor, as compared with that of other systems, lies in the absence of a commutator, whereby the most frequent source of trouble is avoided. The motor is a good mechanical apparatus, with nothing particular to get out of order, and one could afford to sacrifice many advantages for the sake of employing such a motor for train driving. The weakest feature lies in the small air-gap necessary, which requires exceedingly good and well-designed bearings. These, however, can be provided without difficulty.

Conclusion.

The chief immediate developments in the direction of railway electrification are to be looked for in urban and suburban districts, where the increased schedule speed and the greater capacity of an electrically-operated railway could be relied upon to develop the necessary traffic, whilst frequent and regular trains would do much to prevent the loss of traffic to tramways, so often deplored by railway directors at the present time. It is these considerations rather than the possible saving in operating expenses which constitute the case for the electrification of suburban lines.

Taking all things into consideration, the continuous-current system appears by far the most suitable for suburban service in this country, and there are no present indications that it is likely to be superseded for this class of service.

In one respect the London suburban service on such systems as the Great Eastern Railway will afford an engineering problem differing considerably from those with which we are familiar—the trains at times of dense traffic will be considerably heavier than has been usual in electrical suburban service. The use of excessively heavy trains is fraught with consequences likely to lead to a radical departure from the present standard practice. The coaches will probably be of the present compartment type, on account of their greater seating capacity as compared with the corridor type,

and, in fact, the present coaches could be largely employed in making up the trains.

The objections to the continuous-current system, when heavy trains are to be employed, arise for the most part from the necessity for using a third rail. This being accessible constitutes a source of danger, whilst it is exceedingly difficult to install at complicated junctions. Moreover, the system is hardly the most suitable for long-distance service, so that objection has been made to it on the ground that it cannot be generally extended throughout a railway system. This last objection, however, is of little weight, as electricity cannot compete with steam for general railway work in this country, so that universal electrical operation may be ruled out of account. The danger to workmen and others arising from the presence on the line of an accessible conductor at dangerous potential is patent, and can only be obviated by rendering accidental contact with the conductor impossible. An efficient wooden protection for this purpose will add perhaps 5 per cent. to the total cost of electrification, so that the question of additional danger is not a very effective argument against the continuous-current system. The third-rail protection, moreover, by preventing short circuits with track tools, is a valuable security against shut-down. It is worthy of note in this connection that the New York Central and Hudson River Railroad have adopted a completely protected third rail within their New York City electrical zone.

The difficulty of installing line conductors amongst the intricate switchwork and signal rods of a large terminus or junction is serious, and is increased fourfold, as far as a great portion of the London district is concerned, by the action of the underground railways in adopting an insulated return conductor instead of employing the track rails as return. Where the trackwork is not too complicated, a single conductor can usually be installed, so that contact is never lost by the collector shoes, whilst even at the most intricate junctions it can always be located overhead. With a second insulated conductor, however, it is at such places practically impossible to secure continuous contact for both sets of collector shoes within the length of a locomotive or motor coach, and sometimes even of a long train. If the insulated return is adhered to throughout the London district, much rearrangement of track and signal rods will be needed at many termini and junctions. The chief argument in favour of an insulated return is that it enables the track rails to be used for signalling purposes.

The best system of operation is a matter for investigation in particular cases, depending on considerations already discussed. It may be mentioned, however, that in the case of newly-projected lines intended entirely for this class of service, there is some advantage in adopting the continuous-current or the single-phase system, since very little grading is required if either of these systems is employed, the motors being capable of operating efficiently on much steeper grades than could be permitted in steam service. The former of these systems is particularly suited for operating where grades are excessive, on account of the large range of tractive effort and moderate range of speed of the motors. In the single-phase system the speed varies rather too much with change of train resistance to be quite satisfactory, but, on the other hand, the tractive effort can, within limits, be adjusted to the speed and grade by varying the potential difference between motor terminals—that is, by changing the running tap on the main transformer. In many cases the extra cost of electrification would be saved in the diminished excavation, and the lower cost of land due to the greater latitude of location possible when grades are unimportant. The light agricultural railways under consideration in some quarters should undoubtedly be electrically operated.

Opening the discussion, Mr. Philip Dawson referred to his interest in the electrification of one of the London railways, and remarked that the allowance for inertia with single-phase motors on the Brighton line amounted to 13 per cent. He could not admit that the efficiency of the S.P. motor was more than 4 per cent. less than that of the D.C. motor, and including rheostatic losses, with more efficient control, by voltage variation, the loss was much smaller. The S.P. motor characteristic coincided with that of the D.C. motor in fig. 2. The efficiency of the D.C. system was rather 74 or 75 per cent., than 78 per cent.; that of the S.P. system was correctly stated at 87 per cent. He thought the voltage used on the S.P. system might be considerably higher than 6,000 volts. The power-factor of the D.C. system with rotary converters was practically equal to that of the S.P. system. In view of the progress made with the S.P. motor in four years, he did not see why further development should not be looked for in the future. Regarding weight, the S.P. motors were certainly heavier, but not to the extent stated; on American rating, a 150-H.P. D.C. motor weighed 2·7 tons as compared with a S.P. 115-H.P. motor weighing 2·4 tons, and when two complete motor-trucks were compared the weights were 26 tons D.C. against 27 tons A.C. The car-bodies must also be considered; no railway manager would hesitate to use a 15-ton body in place of 10 tons, if he could gain better accommodation thereby. The trucks would weigh 3 tons more, so that the total difference of weight would be 24 tons in a three-car train, quite apart from the motor equipments, and more important. The multiple-unit control was perfectly applicable to the S.P. system, and simpler than with D.C. He could not agree that the S.P. compared unfavourably with D.C. for suburban service, or that the energy consumption was greater. His own figures showed that on a level run of 2,583 ft., the running time being 91·46 seconds D.C. and 92·25 seconds A.C., the average efficiency was 73·6 per cent. D.C. and 74·2 per cent. A.C. The watt-hours per ton-mile were 68 D.C. and 63 A.C. Acceleration to 25 miles per hour was effected in 37 seconds D.C. and 22·5 seconds A.C.; with the former the acceleration was high at first, and then fell off, while with the latter it was low at first, and rose to a high steady value very suitable for suburban service. It was the unanimous opinion of railway men that electricity would never displace steam so long as the third and fourth rails remained, and the success of the S.P. motor was due to the realisation of this fact.

Mr. A. P. Trotter, first pointing out that his remarks were unofficial, agreed that A.C. traction was the coming thing; the pressure was immaterial, but the system must be safe. The electrolytic effects of alternating current were about half those of direct current. On the L.B. and S.C. Railway, the rails were to a great extent insulated from earth by sleepers, ballast, brick viaducts, &c., and 20 volts drop would not be objected to. Regarding the pilot wire, the author was right in theory, but how could the pilot wire be correctly placed in practice? He would borrow a telephone circuit of large area for the purpose of testing the actual drop. But earth currents were not likely to give trouble. It was possible that the railway current might synchronise with the Wheatstone transmitter and confuse the signals. The impedance in the rails at Spindlersfeld was less than that met with on the Swiss railways. The compartment type of coach, with the corridor along one side, and doors to each compartment, offered many advantages.

The meeting was adjourned until the 9th ult., when

Mr. Schoepf found fault with the author's system of "train curves"; in actual work he considered it better to adopt the point by point method, as certain factors could not be obtained by an anylytical method. The author's conclusions in regard to single-phase equipments were contrary to those of other authorities on the subject. For D.C. working, the author added on account of rotary inertia, 8 to 10 per cent. of the train weight, while for single-phase A.C. motors he would possibly double that amount; Mr. Schoepf's experience led him to add 10 to 12 per cent. for D.C., and 12 to 15 per cent. for single-phase A.C. The actual calculated additions were 12·1 per cent. in the case of the Metropolitan Railway, and 14·5 per cent. for single-phase cars proposed for the Brighton Co.'s line; the train weights in the two cases were 160 tons and 105 tons respectively, so that not much difference existed between them. With reference to leakage currents, &c., the effective drop should be only the ohmic drop, on account of the smaller A.C.; there was no need for a negative booster, and rail drops of 60 to 100 volts gave no indication of destructive effects. As regards the pressure to be used on single-phase systems, he considered that there would be no practical objection to 20,000 volts, which had been used with success. The range of power with a single-phase equipment would not be restricted, as the motors would be chosen to suit the case, and in regard to weights, a 150-H.P. A.C. motor weighed 5,398 lb., and a direct-current motor of similar power, 5,550 lb., while a complete Metropolitan motor coach (D.C. equipment) weighed 29,500 lb., and his proposed motor-coach for the Brighton Co. weighed 31,500 lb., a very small difference in practice. The author's particulars for the Cincinnati cars omitted to make mention of the fact that they were longer cars and had heavier equipments owing to their being worked on three voltages.

Mr. H. M. Hobart said that for main line working, high pressures and overhead equipment were a necessity, but there were disadvantages with single-phase motors. He suggested the use of high-tension D.C. and suitable motors, it being possible to get better results as regards commutation by increasing the pressure, with increased capacities such as would be necessary for railway work. There was considerable misconception as to the possibilities of commutation which would exist under the system he advocated.

Mr. C. F. Jenkin remarked that in laying out a motor for service the range of power was not considered; he thought the speed was lower for a given tractive effort with single-phase A.C. motors. The single-phase motor was more self-regulating, and this was an advantage, as resistance had to be kept in longer with the D.C. motor. The use of auxiliary poles on motors was good for commutation, and dispensed with resistance. The Siemens-Schuckert Co., in considering their first single-phase A.C. line in Germany, had calculated the comparative efficiencies (bus-bar to wheel) and costs of several systems, and their results were as follows:—Single-phase, 71 per cent.; three-phase, 66 per cent., and D.C. 62 per cent., with first costs in the ratio 100, 116 and 125 respectively, a showing in favour of single-phase for the particular case.

Mr. P. V. McMahon, referring to the earlier part of the discussion, remarked that on the City and South London Railway, with a 1,000-volt three-wire system, the efficiency of a sub-station 2¾ miles from the power house, and including cable losses, was 86 per cent.; while another, situated 5¼ miles away, had an efficiency of 81 per cent., and the efficiency over the whole line was 90 per cent. Of course the system might not be suitable for the Brighton line, but it could be combined with the single-phase system with advantage as regards electrolysis. His system had proved perfectly satisfactory in working, and it had been found that balancers were unnecessary, as the traffic balanced itself. The third rail system had many advantages over the third and fourth rail system; the overhead system, if properly constructed, would be costly. There was no special difficulty in regard to the use of a third rail at main line junctions, although a third and fourth rail would be absolutely debarred if locomotives were to be used, on account of collecting difficulties.

Mr. W. M. Mordey submitted that the author had arrived at two conclusions—the hopelessness of main line working and the inadequacy of the single-phase system; these were in opposition to the majority of engineers. The speaker thought that a H.T. overhead system would not prove more dangerous to life than, for instance, the Liverpool and Southport line. The author's diagram of "energy dissipation" showed how inefficient the D.C. equipments were, when resistance and brake losses were considered. Even the Liverpool Overhead trains only used 21 per cent. of their

equally arbitrary, and is useless for the purpose of making a service comparison with the continuous-current motor. In suburban service, as we understand it in this country, a single-phase railway will probably be of the present compartment type, on account of their greater seating capacity as compared with the corridor type,

energy in driving, while 50 per cent. went in the brakes, and on the Central London, where the contour of the line aided efficiency, braking absorbed 23 per cent., and motor and resistances a like amount. He could not agree with the author that the power and energy would be higher with single-phase motors; tests made by himself on an A.C. single-phase locomotive showed that they could obtain 34 per cent. more than full load torque, with only 38 per cent. of full load current, which, compared with D.C. motors in series-parallel, meant that the load, instead of being 50 per cent. more than with D.C., would be some 30 per cent. less. The weight of the equipment was in any case a small percentage of the train weight, and the author had himself pointed out that weight was of secondary importance in main line high-speed work. Boosters, as a rule, sucked energy out of the rail, but the author apparently intended to force it in. He concluded by referring to his paper, in conjunction with Mr. B. Jenkin, read before the Institute of Civil Engineers four years previously, and the conclusions in favour of single-phase A.C. working there arrived at.

Mr. F. W. Carter, in replying, pointed out that his objections to single-phase working applied principally to severe suburban service, and Mr. Mordey had misunderstood them in regard to main line working. To Mr. Dawson he replied at length. He had not suggested that the multiple-unit system of control could not be used with single-phase motors, as it was a simpler matter than with the series-parallel combinations of continuous current. Mr. Dawson gave a comparison of single-phase and continuous current equipments for the same service in which the respective equipment efficiencies were given as 74·2 per cent. and 73·6 per cent.; the losses would be 25·8 per cent. and 26·4 per cent. respectively, *i.e.*, practically the same in the two systems, although actually every effort had been made to increase the losses in the continuous-current system in order to make it compare unfavourably with the other. The 115-H.P. motor referred to would give somewhat less than 90 H.P. through the gears if the temperature rise were limited to 75° C., as required for comparison with continuous-current motors. Again, its weight was 2·4 tons, including pinion. A 175-H.P. D.C. motor, rated in the same manner, weighed 2·15 tons, including pinion. The weight per H.P. on the same basis of rating was therefore more than twice as great in single-phase as in continuous-current motors. Comparative figures of single-phase and continuous-current operation for a particular run of 2,583 ft. were given, which showed that the D.C. motors were quite unsuitable for the service, and were not employed in their normal manner. The rate of acceleration has been kept down below that of the single-phase motor, and to make the period of rheostat running as long as possible to give a high energy consumption. Furthermore, much greater D.C. capacity than single-phase capacity had been included in the equipment. Of the 26·4 per cent. loss in the D.C. equipment, at least 15 per cent. was lost in rheostats, 5 per cent. in gears, and not more 6·4 per cent. in motors. Of the 25·8 per cent. loss in the single-phase equipment, not more than 3 per cent. was lost in the compensating transformers, 5 per cent. in gears, and at least 17·8 per cent. in motors. As the input per train-mile would probably be greater in the latter system (in spite of the lower input per ton-mile), the motor loss could not be much less than three times as great in the single-phase as in the D.C. motors. Although the former motors were larger, they would be unable to dissipate more than 20 per cent. or 25 per cent. more heat than the latter with the same internal temperature. Actually the single-phase motors were over-run to show their dynamical capability, and the continuous-current motors were under-run, as the eight motors were more than were required to propel the train. If with the single-phase system the accceleration were kept up to the highest speed, a much higher peak of power were obtained than if the rate of acceleration diminished as high speeds were reached. The maximum peak of power on the Central London Railway occurred when the four motors were each taking their accelerating current of 200 amperes at 550 volts, being then 440 KW. The ratio of the maximum to the average input (77 KW.) was 5·7. In severe suburban service, where many trains were operated at a high schedule speed, the cost of the electrical installation would be from 20 to 40 per cent. greater in the single-phase than in the D.C. system, whilst the electrical power and distribution expenses would probably be quite 20 per cent. greater, and the operation much less reliable. Mr. Schoepf referred to rotary inertia; he (Mr. Carter) had usually found it about 18 per cent. In regard to electrolysis, the speaker preferred to believe Mr. Trotter. Mr. Schoepf gave comparative weights of 150 H.P. continuous-current and single-phase motors. The particular type of motor in which Mr. Schoepf was interested was rated simply as a D.C. motor, which gave no information whatever as to what it would do as a single-phase motor.

Physical Society.

At the annual general meeting on February 9th, Prof. J. H. Poynting, F.R.S., President, in the chair, the reports of the Council and the Treasurer were read and adopted. Messrs. F. Kohlrausch and A. A. Michelson were elected as Honorary Fellows of the Society.

The following Officers and Council were elected for the ensuing year:—

President.—Prof. J. Perry, F.R.S.

Vice-Presidents.—Those who have filled the office of President, together with C. Chree, LL.D., Sc.D., F.R.S.; H. M. Elder, M.A.; Prof. J. A. Fleming, M.A., D.Sc., F.R.S.; and J. Swinburne.

Secretaries.—W. R. Cooper, M.A., and Prof. W. Cassie, M.A.

Foreign Secretary.—Prof. S. P. Thompson, B.A., D.Sc., F.R.S.

Treasurer.—Prof. H. L. Callendar, M.A., LL.D., F.R.S.

Librarian.—W. Watson, D.Sc., F.R.S.

Other Members of Council.—T. H. Blakesley, M.A.; A. Campbell, B.A.; W. B. Croft, M.A.; W. Duddell; J. A. Harker, D.Sc.; W. A. Price, M.A.; S. Skinner, M.A.; S. W. J. Smith, M.A.; W. Watson, D.Sc., F.R.S.; Prof. H. A. Wilson, M.A., D.Sc.

Prof. J. Perry then took the chair and delivered an address. He thought that every young reader of a paper before a Scientific Society made the mistake of assuming that his audience knew a great deal of the subject so familiar to himself, and hence his paper was not understood. Writers of books on Physics assumed their readers to be all truly logical students; they used words properly in a technical sense, and forgot that many of their readers might use them in the newspaper writer's sense.

Referring to the teaching of Physics to students entering upon the engineering profession, the President remarked that such teaching was nearly always slipshod. Every pupil entering a Science College ought to have been experimenting and working graphically and numerically on Physical Science problems from a very early age, and then our science classes would deal with them in a scientific way. For example, such a simple mathematical idea as that of a decimal could not be given in elementary schools in less than five or six years, whereas one week of weighing and measuring would give young children familiarity and clear ideas about decimals. Nothing ought to be compulsory in schools except the study of English and of Natural Science. The only language which ought to be compulsory in the science department of a University was English. A professor of science ought to be allowed to teach his students in the way that seemed best to him, and he should examine his students himself. There was no one general elementary course in Physics which all students ought to take: neither by their previous training nor from the uses which they would make of the principles of Physics were they fit be to taught together. What was wanted was more classes, more rooms and more teachers.

A CONTRIBUTION TO THE THEORY OF THE SINGLE-PHASE INDUCTION MOTOR.

By VAL. A. FYNN.

(*Continued from page* 275.)

If the power factor of the motor were unity, seeing that some loss must occur in the motor even at no load, such machines when running light would *exceed* the synchronous speed.

Having fully recognised the important facts here set forth, the author directed his attention to the speed regulation of such motors, following thereby as closely as circumstances would allow the usual continuous-current practice. It is not proposed in this contribution to do more than indicate the general lines on which such speed variations can be economically secured, and how such motors can be made to run at constant speeds differing from the synchronous to any desired extent, in other words, how their speed can be adjusted independently of the periodicity of the supply, and the number of poles of the machine.

The general plan followed for the case of induction motors is to vary from the natural the relations between the E.M.F.'s, (E T) and E B, and any of the factors which influence their magnitude, and thus bring about the equality of these E.M.F.'s at speeds differing, to any desired extent, from the natural speed. This may be accomplished by varying any, or all, of the factors which influence the magnitude of either of these E.M.F.'s, or by varying the magnitude of either E T or E B independently of the factors naturally governing their magnitude.

It has been shown that these machines are really nothing else but shunt motors with this peculiarity, that the working E.M.F. (E T) and the working current are conveyed to the rotor by induction instead of by conduction as in continuous-current practice, that the E.M.F. responsible for the field is generated in the motor-field axis by rotation of the rotor conductors in the transformer field, and that the rotor winding itself is made use of as a field winding. The essential characteristics of these motors are, however, that the rotor self-induction is practically neutralised in the armature axis as primary and secondary ampere-turns are nearly equal and opposed; further, that the field is excited by an E.M.F. practically in quadrature with that impressed on the rotor in the armature axis, and finally, and as a point of smaller importance, that armature and field axes are displaced by practically $180/n$ degrees.

What makes speed regulation for such motors particularly difficult, is the fact that the various factors which

influence the magnitudes of the two E.M.F.'s (E T and E B) which determine the speed of the motor are all dependent one upon the other, and so it becomes difficult to influence the one without influencing at least some of the others. This complication and interdependence is due to the fact that a single-phase shunt induction motor is really a combination of a transformer, of a phase converter, and of a motor, all in one. The author has discovered a number of means for regulating the speed of such machines, some of them directly applicable to the complicated form known as the single-phase induction motor, whilst others achieve the object by first dividing the machine into its component parts, and then regulating each part separately, thus greatly facilitating the process of regulation. In the latter case the phase-converter is separated from the motor proper, but its duty remains the same, namely, that of supplying the E.M.F. which is required to excite the motor-field, and which is in quadrature with the supply. The transformer ceases to be essential in the motor itself, as soon as the phase converter is separated from the motor proper, and it also becomes indifferent whether the rotor winding, or a winding disposed on the stator, is made use of as a field winding.

It may, therefore, be stated that the means for regulating the speed here described relate broadly to an alternate current motor in which the self-induction in the armature axis is neutralised, in which the field excitation is produced by an E.M.F. sensibly in quadrature with that conveying the energy to the motor and in which the field excitation is derived from a phase converter either embodied in the motor itself or separate therefrom. The speed in such a motor is varied by varying the relations between the working E.M.F. impressed on the rotor in the armature axis or the back E.M.F. in that axis and any of the factors which influence the magnitudes of the said E.M.F.'s. In other words, any desired speed is obtained by so varying the said relations as to make the back E.M.F. sufficiently equal to the working E.M.F. at the speed chosen, remembering that the difference between E T and E B must be mainly responsible for an armature current of sufficient magnitude to produce in conjunction with the motor field available at the time the torque required.

For convenience of reference we will divide the alternate current shunt motor thus evolved into four species which lend themselves particularly well to rational speed control, and which can all be operated from a single-phase supply:—

Species 1.—Single-phase alternate current motor with shunt characteristic where the working voltage E T impressed on the rotor in the armature axis is conveyed by induction with the help of a transformer field, and where the E.M.F. responsible for the motor field is generated with the help of the transformer field in the motor itself, the latter acting, when revolving, also as a phase converter. (This species of alternate current shunt motor is now known as single-phase induction motor.)

Species 1*a*.—Single-phase alternate current motor with shunt characteristic where the working voltage E T impressed on the rotor in the armature axis is conveyed by induction with the help of the transformer field, and where the E.M.F. responsible for the motor field is partly generated with the help of the transformer field in the motor itself, the latter acting when revolving as a phase converter, and partly generated in a phase converter independent of the motor. (To simplify matters this species will be treated hereafter as forming part of Species 1.)

Species 2.—Single-phase alternate current motor with shunt characteristic where the working voltage E T impressed on the rotor in the armature axis is conveyed by induction with the help of a transformer field, and where the motor field is generated by a winding disposed on the stator, the E.M.F. responsible for the motor field being generated in a phase converter independent of the motor.

Species 3.—Single-phase alternate current motor with shunt characteristic where the working voltage E T impressed on the rotor in the armature axis is conveyed by conduction, the self-induction of the rotor in that axis being neutralised and where the motor field is generated by a winding disposed on the stator or on the rotor, the E.M.F. responsible for the motor field being generated in a phase converter independent of the motor.

Species 4.—Single-phase alternate current motor with shunt characteristic where the working voltage E T impressed on the rotor in the armature axis is conveyed by conduction, the self-induction of the rotor in that axis being neutralised, and where the E.M.F. responsible for the motor field is either wholly generated in the motor itself with the help of a transformer field co-axial with the armature axis and due to an E.M.F. co-phasal with E T, the motor acting as a phase converter when revolving, or where the E.M.F. responsible for the motor field is partly generated in the motor itself as above and partly in a phase converter independent of the motor.

Some of the methods by which the speed of such alternate current motors with a shunt characteristic can be adjusted to any desired constant speed or varied at will can now be enumerated, before proceeding to the description of some specific examples.

The objects stated can be achieved for the first species of motor (1 and 1A):—

1. By including in the rotor circuit along the motor field axis an E.M.F. in quadrature with the E.M.F. impressed on the motor in the armature axis and varying the magnitude or direction of the former, thus varying the motor field, the regulating E.M.F. being derived from a phase transformer.

2. By producing the motor field by means of interconnected windings partly disposed on the rotor and partly disposed on the stator, and varying the magnitude or direction of the two component fields, and thus varying the motor field.

3. By varying the magnitude of the transformer field and thus varying the motor field whilst keeping E T constant by including in the rotor circuit along the armature axis an additive or subtractive E.M.F. of same phase as the one responsible for the transformer field.

4. By making the inductive relation of that winding in which E B and E T are generated different in respect of the transformer field to the inductive relation of that same winding in respect of the motor field, thus varying either E T or E B.

5. By making use of only a part of the total field in the motor field axis for generating E B and by varying the magnitude of that part, thus varying E B.

6. By including in the rotor circuit along the armature axis an E.M.F. co-phasal with the E.M.F. responsible for the transformer field and either of the same or the opposite direction as E T, thus varying E T or E B.

7. By varying the transformer field, thus varying E T, whilst keeping the motor field constant by including in the rotor circuit along the motor field axis an E.M.F. in quadrature with E T, derived from a phase converter and of suitably varied magnitude or direction.

8. By varying E T as indicated under four or six whilst keeping the motor field constant by including in the rotor circuit along the motor field axis an E.M.F. in quadrature with E T derived from a phase converter, and of suitably-regulated magnitude or direction, whilst also keeping the transformer field constant.

9. By varying the transformer field whilst keeping the motor field constant when produced by interconnected windings partly disposed on the rotor and partly disposed on the stator by suitably varying the direction or magnitude of the two component fields.

10. By varying E T as indicated under 4 and 6, whilst keeping the motor field constant when produced by means of interconnected windings partly disposed on the rotor and partly disposed on the stator by suitably varying the direction or magnitude of the two component fields, whilst also keeping the transformer field constant.

11. By employing various combinations of the means described.

For the second species of motor, when the excitation is derived from a phase converter independent of the motor, the speed can be varied:—

1. By varying the transformer field.

2. By varying the exciting E.M.F.

3. By including in the rotor circuit in the armature axis an E.M.F. in phase with that responsible for the transformer field, and either of the same or the opposite direction to E T.

4. By employing various combinations of the methods described.

Treasurer.—Prof. H. L. Callendar, M.A., LL.D., F.R.S.
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ularly difficult, is the fact that the various factors which

For the third species of motor, when the excitation is derived from a phase converter, the speed can be varied :—

1. By varying the E.M.F. impressed on the rotor in the armature axis.
2. By varying the exciting E.M.F.
3. By combination of the two means.

For the fourth species of motor the speed can be varied :—

1. By varying the E.M.F. impressed on the rotor in the armature axis.
2. By varying the E.M.F. impressed on the rotor in the armature axis and keeping the motor field constant by varying the transformer field.
3. By varying the E.M.F. impressed on the rotor in the armature axis and keeping the motor field constant by including in the rotor along the motor field axis an E.M.F. in quadrature with that impressed on the rotor in the armature axis and derived from a phase converter whilst suitably varying its magnitude or direction.
4. By varying the transformer field and thus varying the motor field.
5. By including in the rotor along the motor field axis an E.M.F. derived from a phase converter and in quadrature with the E.M.F. impressed on the rotor in the armature axis and varying the magnitude of the E.M.F. derived from the phase converter, thus varying the motor field.
6. By disposing the field winding partly on the rotor and partly on the stator, and varying the magnitude or direction of the two component fields.
7. By various combinations of the means described.

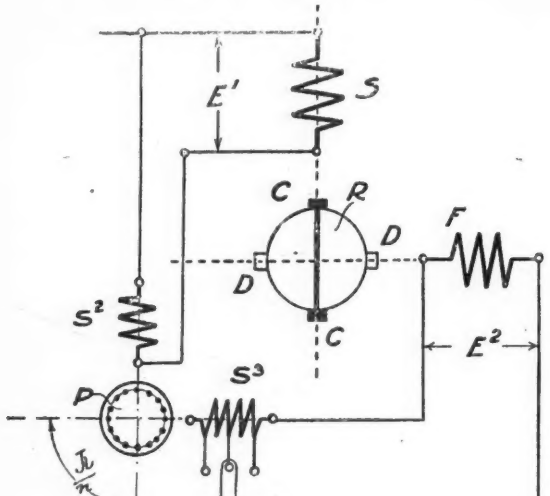

Fig. 4.

The fear of wearying the reader has led the author to curtail the enumeration of the various methods by which alternate current motors with a shunt characteristic and operated from a single-phase supply may be economically regulated for speed. Enough has been said, however, to show that the possibilities are indeed wide, and it will now be easy for anyone to combine two or more of the means already enumerated to suit special conditions or fill any gaps that the author was obliged to leave.

In conclusion, a closer consideration of some of the methods for influencing the more important factors governing the magnitude of E T and E B with relation to speed may prove of interest.

In fig. 4 is shown a motor supplied with two E.M.F.'s differing in phase by 90°. The one E^1 conveys E T, the working E.M.F., and the armature current into the rotor R by induction from S along the axis C C. The other E^2 excites the field in the axis D D. Now E^2 is practically co-phasal with the E.M.F. induced by rotation at the brushes D D, so that this machine closely resembles that shown in fig. 1, and really operates in the same manner; the motor field, however, is not generated by rotation of the rotor conductors in the transformer field, so that the conditions are much simpler and afford a good opportunity for studying the effect of some of the methods which are advocated for varying the speed of such machines.

The phase converter P has been separated from the motor proper, but the transformer field has been retained in the latter. It is not proposed again to refer to the use of a phase converter in conjunction with these motors, as its application in all the other cases will be abundantly clear from this one example; it can be used whenever it is necessary to derive E^2 from a single-phase supply. In this particular case an ordinary squirrel-cage shunt induction motor is made use of as a phase converter; it carries two windings, S^2 and S^3, disposed on the stator and displaced with regard to each other by $180/n$ degrees. The winding S^2 not only conveys the energy necessary to operate the converter as a motor, but also that energy which, after having been suitably transformed, serves to excite the field of the main motor.

The speed can be varied by varying E^2, it will increase as E^2 decreases, because the motor field will be weakened and a greater speed will be required to bring E B up to the original value. E B must be brought up to the original value, because E T has remained unchanged. If E^1 is varied, the speed will increase with increasing E^1 provided E^2 be kept constant. The field remaining constant, the speed must increase with E^1, because E T also increases and a higher speed is necessary to make E B equal to the increasing E T. Saturation, as in the case of continuous current motors, of course sets limits to these variations. The speed can be further varied by including in the rotor circuit along the axis C C an E.M.F. of the same phase as E^1. If that E.M.F. is of the same direction as the one induced by transformer action from S, then E T will be increased and the speed will rise. If that E.M.F. is of opposite direction, then it will help E B. Only a part of the total E B will have to be generated by rotation, and in consequence the speed will fall. It

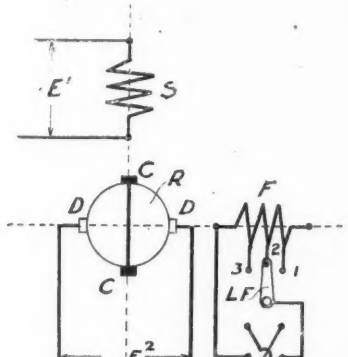

Fig. 5.

should be noted that in this way the speed can be varied within the widest limits, whilst both transformer and motor field remain constant. In this arrangement no motor field is generated by rotation in the transformer field, the latter only serves to convey the working current into the armature. As compared to the arrangement shown in fig. 2, this one has the advantage of enabling the use of very high tensions, but the disadvantage of a greater iron loss due to the presence of the transformer field. For regulating purposes resistances could, of couse, be used in any of the circuits; their use, however, in connection with alternating current machinery is, in most cases, to be condemned. In the present case, inserting resistance into the rotor circuit is equivalent to inserting it into the armature circuit of a continuous current machine. The direction of rotation can be reversed by either reversing E^1 or E^2.

Seeing that the E.M.F. generated along D D by rotation is practically co-phasal with E^2, the arrangement shown in fig. 5 will yield a single-phase shunt induction motor, the speed of which can be adjusted as desired. Bearing in mind the remarks made in connection with the arrangements in fig. 4, it will be at once clear how the various manipulations which have been indicated will influence the behaviour of the motor.

It must, however, be remembered that in all those cases where the motor field is partly or wholly due to rotation in the transformer field, any speed regulation will have a cumulative effect, because every alteration in the speed also brings about an alteration of the motor field.

(*To be continued.*)

NOTES ON THE AMERICAN SYSTEM OF FUSE STANDARDISATION.

By ALFRED SCHWARTZ.

Prior to 1896 the fuses in use in the United States were largely of the open type, consisting of a wire or strip of alloy or aluminium fitting under binding screws or nuts on the fuse blocks. These fuses were in the smaller sizes required for house installation work, mounted on incombustible bases in cut-out cabinets, while the larger sizes were mounted bare on switchboards.

There is an undoubted fire risk with unprotected fuses. They are also a source of danger to the attendant should they blow close to his face or hands. This frequently occurs when repairs or changes are being made on low-tension boards during use, or when a switch is closed on a short-circuited line.

In this country we have developed a number of types of protected or semi-enclosed fuses in which the operator is more or less screened from the molten metal when the fuse blows, whereas in the United States and on the Continent completely enclosed fuses have been evolved. Careful standardisation in this country may enable us to successfully use the semi-enclosed fuse for house installation work, and if so, we shall be the gainers as far as low cost of refills and ease of inspection is concerned, as the enclosed type has to be fitted with an indicating device, and these, apart from their not being always reliable, are sometimes a source of danger. In addition to the ordinary open type or link fuse, a large number of Edison plug fuses are used in the States, and this type, as far as the restriction of the scattering of the metal in fusion is concerned, is quite satisfactory, and, in a modified form, has been adopted as a part of the standard fuse.

The course of action taken in the United States in connection with the work of standardisation has already been referred to (Electrical Review, "The Standardisation of Fuses," November 17th, 1905), the results of this work, together with the tests for approval for enclosed fuses are given in the National Electric Code of 1905 and in the list of approved fittings of April of this year. The writer has been unable to obtain copies of these publications in this country, but has been furnished, by the courtesy of the secretary of the American Institution of Electrical Engineers, with an earlier edition of the national electric code together with a copy of Mr. H. O. Lacount's recent paper on the standardisation of enclosed fuses, from which the following regulations are abstracted.

Open-type Link Fuses.—"The ordinary porcelain link fuse cut-out will not be approved. Link fuses may be used only when mounted on slate or marble conformable to regulation No. 52." This regulation specifies in detail the method of supporting and mounting the bases, and gives particulars as to the construction of the terminals and connections. "They must further be enclosed in dust-tight fire-proofed cabinets, except on switchboards located well away from combustible material."

Test.—"They must operate successfully when blowing only one fuse at a time on short circuits, with fuses rated at 50 per cent. above, and with a voltage 25 per cent. above the current and voltage for which the cut-out is designed."

This is a severe test, and is evidently intended to secure the satisfactory operation of the cut-out with a larger fuse in it than it was designed for—a very possible contingency in actual service. The margin of safety as regards current is satisfactory, but the 25 per cent. increase in voltage, which is presumably intended to take care of irregularities of pressure in the circuit will be quite swamped by the inductive pressure rise due to the breaking of the short-circuit current, as this latter may be many times that of the line voltage.

Spacings.—"Spacings must be at least as great as those given in the following table :—

	Minimum separation of nearest metal parts of opposite polarity.	Minimum break distance.
125 *volts or less*—		
10 amperes or less	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.
11 to 100 amperes	1 in.	$\frac{3}{4}$ in.
101 to 300 amperes	1 in.	1 in.
301 to 1,000 amperes...	1¼ in.	1¼ in.
126 *to* 250 *volts*—		
10 amperes or less	1½ in.	1¼ in.
11 to 100 amperes	1¾ in.	1¼ in.
101 to 300 amperes	2 in.	1½ in.
301 to 1,000 amperes...	2½ in.	2 in.

In the writer's opinion the minimum break distances given above are far too small for safe working ; on 125 volts, for instance, the 1,000-ampere fuse need only be ½ in. longer than the 10-ampere one, while for 250 volts the increase in break for the same range is only ¾ in. ; the inductive pressure rise on blowing does not seem to have been considered when settling these dimensions.

"A minimum space must be maintained between fuse terminals of the same polarity of at least ½ in. for voltages up to 125, and ¾ in. from 126—250 volts."

Rating.—"The fuses must be stamped with about 80 per cent. of the maximum current which they can carry indefinitely, thus allowing about 25 per cent. overload before the fuse melts."

This rating practically excludes the use of copper as a fuse material, as it becomes red hot when carrying about 75 per cent. of its fusing current, and, therefore, oxidises too rapidly. While 25 per cent. excess current is a reasonable allowance for fuses of large carrying capacity, or for circuits which require special protection, it is too low for house lighting work, or for arc lamp and motor circuits in which very considerable variations of current occur.

Marking.—"Fuse terminals must be stamped with maker's name or initials, or with some known trade mark."

Enclosed Fuses—Plug and Cartridge Type Construction.—"The fuse plug or cartridge must be sufficiently dust-tight, so that lint and dust cannot collect around the fusible wire and become ignited when the fuse is blown. The fusible wire must be attached to the plug or cartridge terminals in such a way as to secure a thoroughly good connection, and to make it difficult for it to be replaced when melted."

An enclosed fuse in the smaller sizes is comparatively inexpensive, and the cartridge can be discarded after use, but in the larger sizes there is no valid reason why they should not be arranged for refilling by authorised persons. The danger to be guarded against with this type of fuse is the replacement of the fuse in the cartridge without the filling material around it.

Classification.—"Must be classified to correspond with the different classes of cut-out blocks, and must be so designed that it will be impossible to put any fuse of a given class into a cut-out block which is designed for a current or voltage lower than that of the class to which the fuse belongs."

Terminals.—"The fuse terminals must be sufficiently heavy to ensure mechanical strength and rigidity. The styles of terminals must be as follows" :—

0—250 volts.		Fuse.		Terminals.
0—2 amps.		cartridge fuse (ferrule contact)	to fit	spring clip terminals.
3—30	A	cartridge fuse (ferrule contact)	to fit	(*a*) spring clip terminals. (*b*) Edison plug casings.
	B	Present Edison plugs, 0—125 volts.		
31—60		cartridge fuse (ferrule contact)	to fit	(*a*) spring clip terminals. (*b*) Edison plug casings.
61—100 101—200 201—400 401—600		Cartridge fuse		(knife blade contact).

A similar table is given from 251 to 600 volts for the same current ranges as the above up to 400 amperes. Cartridge fuses must be used throughout with ferrule contacts up to 60 amperes and knife contacts from 61 to 400 amperes.

Dimensions.—"Cartridge enclosed fuses and corresponding cut-out blocks must conform to the dimensions given in the table attached."

Fig. 1 shows the standard ferrule contact and fig. 2 the standard knife blade contact for cartridge fuses. The table referred to follows the same rated capacities for fuses up to 250 and 600 volts, as already given, and gives in each

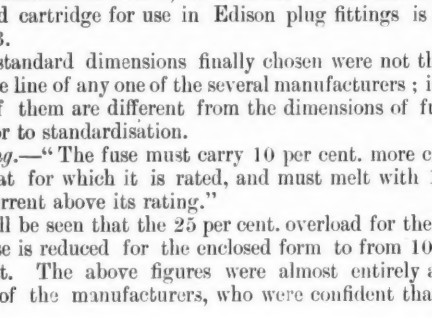

Fig. 1.

case the following dimensions:—Length over terminals A, distance between contact clips B, width of contact clips C, diameter of ferrules or thickness of terminal blades D, minimum length of ferrules or of terminal blades outside of tube E, diameter of tube F, width of terminal blades G. The standard cartridge for use in Edison plug fittings is shown in fig. 3.

The standard dimensions finally chosen were not those of an entire line of any one of the several manufacturers; in fact, many of them are different from the dimensions of fuses in use prior to standardisation.

Rating.—"The fuse must carry 10 per cent. more current than that for which it is rated, and must melt with 15 per cent. current above its rating."

It will be seen that the 25 per cent. overload for the open-type fuse is reduced for the enclosed form to from 10 to 15 per cent. The above figures were almost entirely a suggestion of the manufacturers, who were confident that they

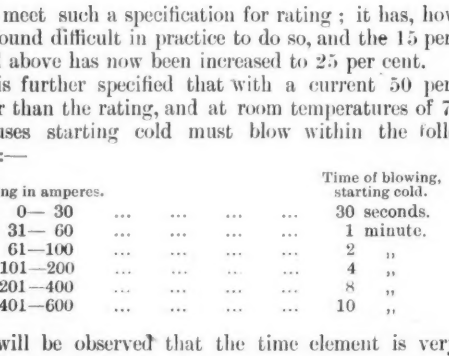

Fig. 2.

could meet such a specification for rating; it has, however, been found difficult in practice to do so, and the 15 per cent. named above has now been increased to 25 per cent.

It is further specified that with a current 50 per cent. greater than the rating, and at room temperatures of 75° F., the fuses starting cold must blow within the following times:—

Rating in amperes.	Time of blowing, starting cold.
0— 30	30 seconds.
31— 60	1 minute.
61—100	2 ,,
101—200	4 ,,
201—400	8 ,,
401—600	10 ,,

It will be observed that the time element is very considerable, particularly in the case of the larger fuses, this is due to the large capacity for heat of the cartridge and filling.

Temperature Rise.—"The temperature of the exterior of the fuse enclosure must not rise more than 125° F. above that of the surrounding air when carrying its rated current."

Test.—"Must not hold an arc or throw out melted metal or sufficient flame to ignite easily inflammable material on or near the cut-out, when only one fuse is blown at a time on a short-circuit on a system having a capacity of 300 KW. or over, at the voltage for which the fuse is rated."

This short circuit test is not nearly so detailed as that laid down in the German regulations; the amount of resistance in the testing circuit is not specified, neither is any stipulation made as to the source and character of the current supply. It is suggested that while the above conditions may be severe enough for fuses up to 100 amperes, for the larger sizes the available capacity at the back of the fuse should be 10 times that at which the fuse is rated.

In some of the tests it was noted that fuses which were satisfactory under severe short circuit conditions, failed if the current flow was limited by a resistance, even when the resistance was very small, for example, with 1,500 amperes when testing 100 and 200-ampere fuses, and *vice versâ*, fuses that apparently were successful with the limited short circuit failed on a dead short. This is due to the fact that in the dead short the whole length of the fuse is disrupted, whereas in the limited one only a small length in the middle of the fuse melts in the first instance, and the arc is held until the fuse is burned back to the terminals. Further, with tin and alloy wires on a gradual overload, the wire will often break up into small lengths, particularly if there is any vibration, and the arc will be maintained across these small gaps with destructive results. The nature of the filling employed would also doubtless be an important factor in preventing the maintenance of the arc; there is no doubt that many fillings

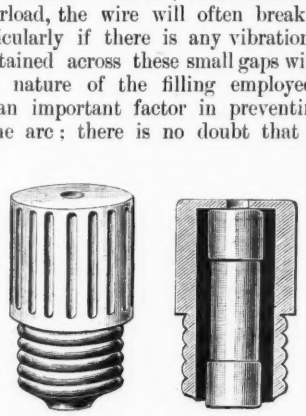

Fig. 3.

when heated by the local arcing referred to above, become partial conductors. Again, the filling may hold up the molten metal and preserve its continuity until a temperature has been attained sufficient to dissipate it. Some fillings are hygroscopic, and the moisture thus absorbed gives rise to electrolytic corrosion of the fuse. In addition to failure due to the holding of the arc, enclosed fuses may fail by the bursting of the cartridge, or the blowing-off of the end caps or ferrules.

In concluding these notes on fuse standardisation, the writer hopes he has been able to show that both on the Continent and in America the fuse has received far more attention than it has in this country, and that, in consequence of the care that has been bestowed upon its standardisation, a far greater degree of certainty of action has been secured, together with a very considerably decreased fire risk.

CONDUIT WIRING FOR ELECTRIC INSTALLATIONS.

(*Concluded from page* 284.)

At the time this light gauge socketed tubing was introduced, no one thought of continuity and earthing; nevertheless, the use of this class of tubing is increasing, in spite of high voltages and the increased use of heavier gauge screwed conduit. Reference was made to devices for securing continuity with socketed tubing, and it was stated that although screwed fittings have to be used, the job comes out cheaper than a completely screwed system.

The author still has great faith in the socketed system; and if, as is apparently the case, the sale for this (with and without continuity devices) is increasing, his faith is justified. It really devolves itself into a matter of opinion, for the socketed system can possess all the advantages of a screwed job—*i.e.*, continuity, mechanical protection, and a complete draw-through—*if properly erected*, without the disadvantage of the higher price. Where price is no consideration, no one would be foolish enough not to use a screwed heavy-gauge conduit; but after all, the main consideration with electric installations is to keep the price down, consistent with good workmanship and material, and ever to have in view the enemy—gas. Mr.

Waterhouse dwelt at some length on the points in favour of socketed tube, as compared with others, and also on the causes of failure—causes which are, or should be, well known to all contractors; and he arrived at the conclusion that if there is failure, it can generally be attributed to carelessness. The manufacturers do their best to make every provision against errors of omission or commission.

Next, the different screwed conduits were discussed, *i.e.*, brazed, welded and solid-drawn tubes, the last of which were said to be the most expensive. The first had an absolutely uniform interior, but in the second the heat necessary for an efficient weld was injurious to the surface and also to the maintenance of a uniform diameter, and there were other disadvantages. The methods adopted to overcome some of these raise the price to the equal of solid drawn tube. The latter is of course excellent where, as stated, price is no consideration, but the author protested against certain specifications which call for qualities that raise the price without any corresponding advantage.

Insulating conduit came in for some notice, but was dismissed for reasons with which most of our readers will be acquainted.

Special attention was drawn to the danger of compo gas pipes in proximity to electric conduits, and reference was made in this connection to the interim re-issue of the rules of the Royal Insurance Co. It was also pointed out that earthing wires should be large enough to carry a main current without dangerous heating, as a fault on a main may only be protected by a large fuse. Attention was also drawn to Mr. Lackie's suggestion last year that conduits should be entirely insulated, and Mr. Waterhouse endorsed this if it could be made practicable. The danger of fire from compo gas pipes could only be averted by insulating the conduit from all metal work, or all compo gas tube must be removed. Rule 12 of the I.E.E. rules was quoted to show that the earthing and continuity of conduits is only required for currents at pressures *exceeding* 250 volts (we have pointed out this apparent laxity, in criticising the rules), and Mr. Waterhouse thinks it was so framed owing to the large number of socketed systems, neither continuous or earthed, which had been erected before the drafting of these rules, and of which only a very small percentage had been found to be faulty.

Surface work was referred to, and it was hinted that this would become the vogue even for dwelling rooms, perhaps with an open seam for ventilation. For concealed work in plaster seamed tube should not be employed, and where the runs terminate in a switch, plug or box it was recommended that a draining outlet should be given them by using a tee piece.

The mounting of switches, plugs and ceiling roses came in for some criticism, and the screwing of these accessories direct into the lugs of the iron box was condemned, owing to the very short leakage path provided. It was preferable to use an insulating seating or a ring screwed on to the fitting, the whole being then secured to the box.

The paper concluded with a statement of those materials which the author considered most suitable for a satisfactory conduit installation, but with a reminder that as a manufacturer his duty to his shareholders was to make those articles for which there was a reasonable demand. Mutual discussions such as this, between makers and users would, however, be useful in many ways. Contractors were asked not to expect immediate delivery at standard prices of special articles, but to co-operate with the manufacturers to the advantage of the industry, and a special plea was made against excessive cutting, which would lower the standard of workmanship and material that now obtains.

The discussion was opened by Mr. Strode, who deprecated the condemnation of casing, which was still useful in old buildings. He condemned the use of any but strong screwed tubing in fire-proof buildings, solid-drawn and galvanised. Socketed he would not have at any price, whilst enamel peeled off with damp, and rust resulted. He was against surface tubes in dwelling rooms; the system must be draw-through or nothing.

Mr. Johnson, referring to Mr. Lackie's suggestion, said he could not find anything suitable for insulating tubing running over girders in fire-proof floors. Mica had many objections, whilst fibre cracked. He asked for information on the point. As regards continuity devices, he thought their use must bring up the cost of a socketed to that of a screwed system. He disagreed with Mr. Strode regarding the use of casing in old buildings. After some years' accumulation of dust the capping swelled off, and then water was liable to enter. As regards a screwed system, he thought that the price was an objection, whilst the oil used on the dies ruined the insulation. He had no knowledge of electrical fires where steel tubing had been used.

Mr. Lewin called for standardisation owing to the difficulty of fitting new tubing and fittings on extensions of old installations. He drew attention to the trouble from rusting, and said that both enamelling and galvanising soon succumb.

Mr. Lester Taylor spoke, as a fire office inspector, with some force on the subject of compo gas pipes. Whilst heavy-screwed conduit was, no doubt, the best, he said that the fire offices did not care about earthing, as it introduced a mischievous element in connection with motors, whilst the leakage current would always prefer the path through a compo pipe to that through the earth wire. He thought that casing did cause fires in old buildings. The insulation of conduits was not practicable in modern buildings; the only solution was to prohibit the use of soft-metal gas pipes. As regards thin conduits, he did not object to these; they were useful in small houses where cheapness was the object and, therefore, he supported them.

Mr. Leonard Tate asked why steel tube rusted sooner than iron barrel. He preferred casing for surface work, as it made a neater job. He read a letter from Mr. Russell, of the Phœnix Fire Office, who said he only used heavy-gauge solid-drawn tube, and did not like open-joint tubes. As for himself, he preferred casing or solid-drawn tube.

Mr. Gunner (representing the G.E.C.) asked for information regarding fire-proof casing. As regards the historical point of view, he claimed that insulating tube was on the market first, and was the best now if people liked to pay the price. He did not think that socketed tube was to disappear. For surface work oval tube could be well used, and was quite as neat as casing. He did not care about using insulating seating disks for accessories, as the wiremen were apt to strip the threads by overturning the screws. He preferred screwing direct on to the metal box, and said that the accessories could easily be so designed as to keep the head of the terminal further away from the metal screw. Contractors were much too prone to drop on manufacturers if anything went wrong, when it was very often only due to the carelessness of their own men. Casing men were put on to screw conduits, and wires were trodden on before being drawn in. He particularly criticised the sending in of orders with incomplete particulars.

Mr. Schmahl (Armorduct Manufacturing Co.) agreed with Mr. Strode that casing might be satisfactory for certain work. It was at any time preferable to close joint tube. He was suspicious of the continuity devices, and would like to know something about tests made on finishing a job and after some time; also, how the cost compared with a screwed system. He approved of galvanised tube, but we were not sufficiently advanced with the electrical process, whilst the hot galvanising process was not altogether suitable. Efforts should be made towards improving enamelling, which was better now than it used to be, and could be made to resist the acids and alkalis in plaster. It was unnecessary for him to state that he advocated welded tubes himself. They were quite satisfactory if of heavy gauge, made with a good weld. The price of best solid drawn tube was double, and he warned members that solid drawn tube was still being made from scrap. He favoured iron because it would resist corrosion longer than steel, and we should have to substitute iron for steel unless thicker tubes were made. As regards fittings, he considered these unsatisfactory. For good work, all that was required was a good tube and a good box.

Mr. E. L. Berry made a special point about the nuisance of the large amount of fittings now listed. The work for the storekeeper must be enormous, and no wonder one received fittings not ordered, whilst those ordered did not come to hand.

In replying, Mr. Waterhouse thanked the meeting for dealing leniently with him. He maintained his opinion against Mr. Strode's, that socketed tubing was a good thing,

and he confirmed Mr. Schmahl that galvanising was not satisfactory, but he was experimenting on the electrical process, and had hopes of success. He agreed that it was impossible in some cases to insulate tubing; that oil in a screwed system is dangerous; and that iron resists rust better than steel. One secret of good enamelling was that the metal must be absolutely clean before the enamel was laid on. As regards Mr. Russell's action in barring light gauge tube, he did not think that any fire office inspector should refuse material that was doing good and useful work; the remedy was obviously to employ another company. He corrected Mr. Gunner on several points; and as regards stripping the thread in an insulating disk, it was quite easy to get another disk, whilst a man who overturned screws would break the porcelain base when this was screwed direct to the box. Mr. Schmahl did not make light-gauge tube, and his conduit experience was, perhaps, not quite so long as that of others. They were turning continuity nipples out as fast as they could, and had never been able to stock them. As regards the continuity lasting, he had a job through which, when new, he had been able to ring a bell by means of a Leclanché cell, and he could still do so. Enamelling was simply a question of price. If people would pay a good price they could get a good article. In conclusion, he thanked the meeting for their kindness, and the meeting reciprocated with a vote of thanks.

It was announced that at the next meeting of the Association one of Messrs. Crossley's representatives would read a paper on Suction Gas Plant.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

17,957A/1905. "Improvements in step-by-step electric switches." I. B. Birnbaum and H. G. White. (Date applied for under Rule 5 of the Patents Rules, 1905, December 13th, 1905.) February 14th.

3,361. "An improved electric lampholder with improved shade carrier, spring collar and terminals." W. Evans-Day. February 12th.

3,402. "Improvements in and relating to sparking plugs for electric ignition in explosion engines." A. Sharpe. February 12th.

3,415. "Improvements in adjusters for electric light cords." J. T. Hatherly and T. H. Hatherly. February 12th. (Complete.)

3,430. "Electrical muscular exercising machines." R. O'Conner Hammond. (Date applied for under Patents Act, 1901, May 23rd, 1905, being date of application in United States.) February 12th. (Complete.)

3,455. "Improvements in magnetic material for electrical purposes and method of producing the same." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) February 12th.

3,456. "Improvements in filaments suitable for incandescent electric lamps and in methods of manufacturing the same." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States). February 12th.

3,457. "Improvements in and relating to electric arc lamps." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States. February 12th.

3,540. "Improvements in or relating to electrical time-switches." R. F. S. Venner and R. C. Griesbach. February 15th.

3,541. "Improvements in safety appliances for electric circuits." Siemens Bros. & Co., Ltd. (Siemens Schuckertwerke G.m.b.H., Germany.) February 13th. (Complete.)

3,574. "Improvements in arc lamps." A. J. Sauvanet, E. L. J. Teurtroy, P. E. Chaligne and P. M. Capitaine. February 12th.

3,581. "Improvements relating to electric machines for use in the production or expenditure of electricity." M. W. Ward. February 13th.

3,583. "Apparatus for producing nitric oxides by electricity." I. Moscicki. February 13th. (Complete.)

3,590. "Improvements in and relating to alternating current motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 13th.

3,604. "Improvements in electric exploding apparatus." H. Davis. February 14th.

3,613. "An improved method of mechanical continuity and earthing device in the erection, fixing, and the like in electric cable conduits." W. C. Williams. February 14th.

3,620. "Improvements in contacts for use in connection with electric warning signals for railways and the like." J. H. Hollyer. February 14th.

3,630. "Improvements in and relating to multiplex telegraphy." S. D. Field. February 14th. (Complete.)

3,657. "Improvements in dynamo-electric machines." B. G. Lamme. (Date applied for under Patents Act, 1901, February 21st, 1905, being date of application in United States.) February 14th. (Complete.)

3,663. "Improvements relating to magnetic clutches." F. R. Martin and O. M. Shepherd. February 14th.

3,677. "Improvements in apparatus for reducing the fluctuations of load in the current generators of alternating current installations." Siemens Bros. and Co., Ltd. (Siemens-Schuckertwerke G.m.b.H., Germany.) February 14th. (Complete.)

3,684. "Improvements in and relating to the manufacture of incandescing bodies for electric incandescent lamps." A. Just, F. Hanaman, H. Landesberger, I. Salzman and the Firm Vereinigte Elektricitats Akt.-Ges. February 14th.

3,713. "A new or improved vacuum tube or tubes for the production of violet or ultra-violet, or X-rays or other rays, or combination of rays, on high or low tension, alternating or direct electric currents." J. C. Bowie and J. H. Phelps. February 15th.

3,714. "Improvements in or relating to electric arc lamps." A. D. Jones and the Jandus Arc Lamp and Electric Co., Ltd. February 15th.

3,715. "Improvements in or relating to electric arc lamps." B. M. Drake, A. D. Jones, and the Jandus Arc Lamp and Electric Co., Ltd. February 15th.

3,716. "Improvements in or relating to electric arc lamps." B. M. Drake, A. D. Jones, and the Jandus Arc Lamp and Electric Co., Ltd. February 15th.

3,760. "Improvements in or relating to sparking plugs for internal combustion motors." Simpson, Strickland & Co., Ltd., and B. H. Joy. February 15th.

3,769. "Improved trolley-wheel collector for electric traction." J. A. Kidd. February 15th.

3,781. "Improvements in and relating to electro-magnetically-operated switches." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 15th.

3,783. "Improvements in electric fuses." O. L. Peard. February 15th.

3,784. "Improvements in electric fuses." O. L. Peard. February 15th.

3,800. "A sparking plug protector." R. G. Nye. February 16th.

3,890. "Improvements relating to incandescent electric lamps." W. R. Lake. (Parker Clark Electric Co.) February 16th. (Complete.)

3,902. "Improvements in electrical igniters or sparking plugs." C. Robinson. February 16th.

3,904. "Improvements in and relating to electric measuring apparatus." The British Thomson-Houston Co, Ltd., and F. Holden. February 16th.

3,907. "Improvements in and relating to telephone intercommunication systems." A. Ekstrom. February 16th.

3,908. "Improvements in or relating to telephone communication systems." A. Ekstrom. February 16th.

3,937. "Improvements in the method of and means for electrically heating materials to be rolled or drawn." S. B. Halcomb, P. MacGregor and J. F. Bennett. February 17th.

3,956. "Improvements in megaphones." H. Roberts. February 17th.

3,988. "Improvements in incandescent electric lamps." M. Schade. February 17th. (Complete.)

3,990. "Process for decomposing water by electrolysis." W. F. M. McCarthy. February 17th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

Electrical Prepayment Meters. Chamberlain & Hookham, Ltd., and S. P. Holden. 6,954. April 3rd.

Electrical Signalling Device for Motor-Cars and other Vehicles, and for other Purposes Available for Night and Day Use. W. E. Williams. 7,828. April 12th.

Electric Arc Lamps with Multiple Electrodes. W. Gamble. 8,563. April 20th.

Combined Curb Stone and Electric Wire Conduit. W. J. Donohue. 9,455. May 4th.

Electrical Fuse Boxes. W. T. Henley's Telegraph Works Co., Ltd., and W. H. Nicols. 10,296. May 16th.

Electrical Signalling Apparatus Particularly Adapted for Signalling in Mines. L. B. Woodworth. 10,793. May 23rd.

Clutch Mechanism for Detachably Connecting an Arc Lamp, or other Appliance or Apparatus to a Post, Pillar, or other High-Up Support at a Point Out of Reach. Veritys, Ltd., and F. S. Worsley. 10,816. May 24th.

Brush-Holders for Dynamo-Electric Machines and the like. Speits and J. Frith. 11,061. May 26th.

Electric Insulating Tapes. Callender's Cable and Construction Co., Ltd., and G. Barnard. 11,142. May 27th.

Mounting and Heating Cylindrical Thermo-Electric Generators. Cie. Thermo-Electrique (Systeme Hermite) Soc. Anon. (Date applied for under International Convention, May 3rd, 1905.) (Originally included in 11,301 of 1905.) 11,301A. May 30th.

Methods and Apparatus for Producing Electric Sound Signals. C. P. O'Brien. 11,921. June 7th.

Single-Phase Alternating Current Motors. Siemens Schuckert Werke G.m.b.H. (Date applied for under International Convention, December 19th, 1904.) 14,320. July 11th.

Call Signal Apparatus for Group-Calling in Telephone Installations. Siemens Bros. & Co., Ltd. (Siemens & Halske Akt.-Ges.) 16,484. August 14th.

Electrical Transformers for Measuring Apparatus and the like. C. Olivetti and D. Gatta. (Date applied for under International Convention, August 25th, 1904.) 17,222. August 25th.

Sparking Plugs for Internal Combustion Engines. A. J. Boult. (L. Macquaire.) 18,832. September 18th.

Method for the Production of Hollow Poles of Concrete with a Metal Insertion Forming an Inter-Connected Framework for Electric Conductors and the like. H. Aebi. (Date applied for under International Convention, November 21st, 1904.) 21,095. October 17th.

Electric Power Measuring and Recording Instruments for Alternating Currents. V. Arcioni. (Date applied for under International Convention, October 27th, 1904.) 21,855. October 26th.

Portable Electric Drilling Machines. J. Maclean. 668. January 12th.

Apparatus for Use in Recording Telephonic Messages or Sounds. H. Starcke. 1,299. January 23rd.

Electric Switches, Controllers, and the like. A. B. Soar and H. F. Joel, jun. 1,300. January 23rd.

Electric Time Switches. J. J. Coachman. 1,493. January 25th.

Coils or Windings for Transformers and other Electrical Apparatus. A. F. Berry. 1,526. January 25th.

Electric Vapour Lamps or Enclosed Arc Lamps. C. O. Bastian and G. Calvert. 2,004. February 1st.

Electrode Material for Vapour Electric Apparatus. C. O. Bastian and G. Calvert. (Date applied for under Rule 5, Patents Rules 1905, February 1st, 1905.) 2,004A. February 1st.

Electric Lighting of Trains. H. Leitner and R. N. Lucas. 2,342. February 6th.

Devices for Controlling Electric Currents. C. W. Atkinson. 2,919. February 13th.

Ironing Machine Tables Having Electrically Controlled Pressure. A. E. Hacking and J. P. Pycroft. 2,998. February 14th.

Electrolytic Meters, Applicable to other Measuring Instruments or Apparatus in which the (Varying) Level of a Column of Liquid is Employed. Bastian Meter Co., Ltd., A. E. Salisbury, C. O. Bastian and G. Calvert. 3,706. February 22nd.

Electric Switch and Circuit Breaker Mechanisms. W. E. Paiton. 3,762. February 23rd.

Automatic Carrier Systems. British Thomson-Houston Co., Ltd. (General Electric Co.) 3,919. February 24th.

Method of and Means for Governing or Controlling Electrically Driven Winding Machinery, Rolling Mills, and the like. H. Pieper. 4,504. March 4th.